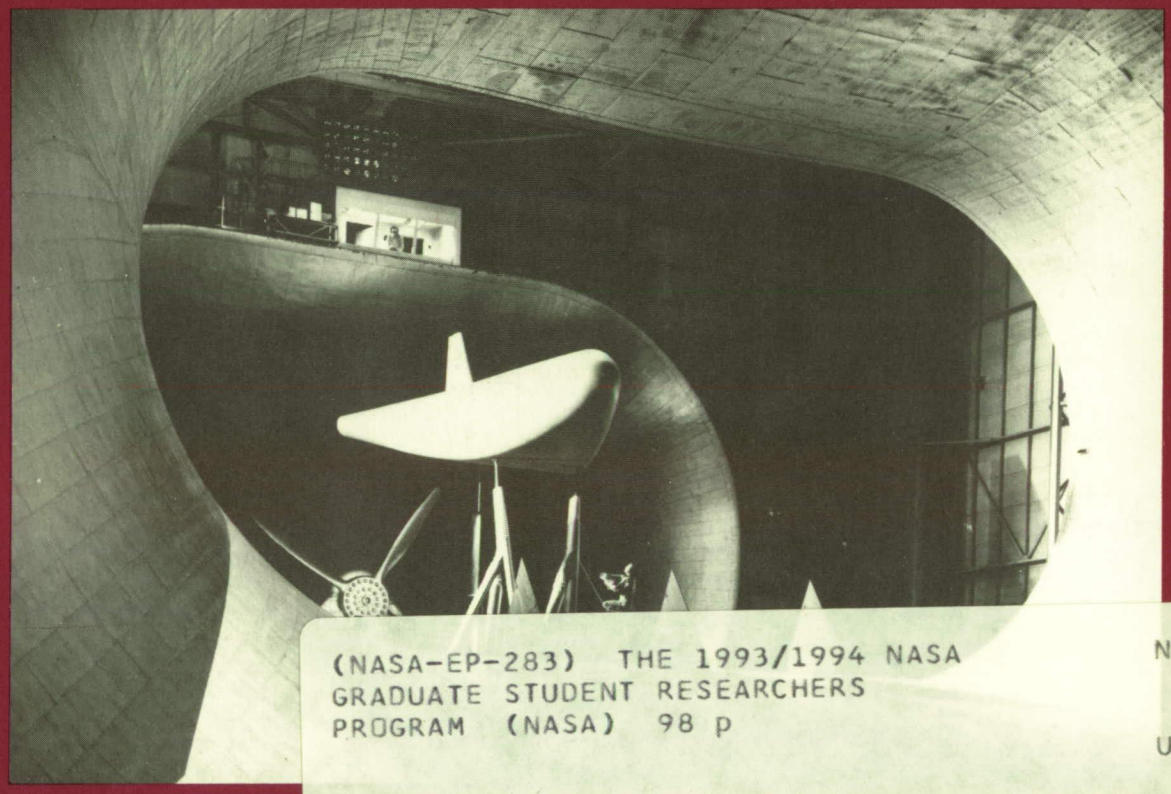
# 1993/94 NASA Graduate Student Researchers Program





National Aeronautics and Space Administration

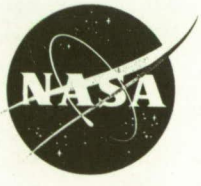
**Cover**

An 8.5-meter model of the HL-10 lifting-body reentry vehicle is mounted in NASA's Langley Research Center Full Scale Wind Tunnel to determine its low-speed static stability and control characteristics.

# *1993/94 NASA Graduate Student Researchers Program*

Higher Education Branch
Education Division
Office of Human Resources and Education
NASA Headquarters
Washington, DC 20546

**EP-283**
**September 1992**



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# *1993/94 NASA Graduate Student Researchers Programs*

*Higher Education Branch*
*Education Division*
*NASA Headquarters*
*Code FEH*
*Washington, DC 20546*

***Introduction — The future of the United States is in the classrooms of America and tomorrow's scientific and technological capabilities are derived from today's investments in research. In 1980, NASA initiated the Graduate Student Researchers Program (GSRP) to cultivate additional research ties to the academic community and to support promising students pursuing advanced degrees in science and engineering. Since then, approximately 1,200 students have completed the program's requirements. In 1987, the program was expanded to include the Underrepresented Minority Focus (UMF) Component. This program was designed to increase minority participation in graduate study and research and, ultimately, in space science and aerospace technology careers. Approximately 230 minority students have completed the program's requirements while making significant contributions to the nation's aerospace efforts. Continuing to expand fellowship opportunities, NASA announced in 1990 the Graduate Student Fellowships in Global Change Research (GSGCR). Designed to support the rapid growth in the study of Earth as a system, approximately 150 fellowships have been awarded since its inception. And, in 1992, NASA announced opportunities in the multiagency High Performance Computing and Communications (HPCC) Program designed to accelerate the development and application of massively parallel processing. Approximately five new fellowships will be awarded yearly.***

***This booklet will guide you in your efforts to participate in programs for graduate student support.***

- **Section II** - lists areas of research activities at NASA facilities. Refer to this section for a detailed description of research opportunities when applying to the GSRP, the UMF, and HPCC fellowship programs.
- **Section III** - describes the Underrepresented Minority Focus (UMF) Component.
- **Section IV** - describes the Graduate Student Fellowships in Global Change Research (GSGCR), their objectives, and administrative and application procedures.
- **Section V** - describes the High Performance Computing and Communications (HPCC) fellowships.

During the next two years, NASA will select at least 400 new graduate student researchers to receive stipends and to work at our unique national laboratories. We are pleased to offer these programs and hope students and faculty will continue to benefit from them.

**Special Note: This booklet should be used for both the 1993 and 1994 graduate programs.**

# Program Summaries

## Graduate Student Researchers Program

The NASA Graduate Student Researchers Program (GSRP) attempts to reach a culturally diverse group of promising U.S. graduate students whose research interests are compatible with NASA's programs in space science and aerospace technology. Each year we select approximately 100 new awardees based on competitive evaluation of their academic qualifications, their proposed research plan and/or plan of study, and their planned utilization of NASA research facilities. Fellowships of up to $22,000 are awarded for one year and are renewable, based on satisfactory progress, for a total of three years. Approximately 300 graduate students are, thus, supported by this program at any one time. Students may apply any time during their graduate career or prior to receiving their baccalaureate degree. An applicant must be sponsored by his/her graduate department chair or faculty advisor; other eligibility requirements are described in the Administrative Procedures section of this book.

Fifty of the 100 new awards each year are sponsored by the NASA Headquarters Office of Space Science and Applications (OSSA) in the fields of astrophysics, solar system exploration, space physics, Earth science, microgravity science and applications, life science, and information systems. Students applying for these fellowships are competitively evaluated on their academic qualifications and proposed research and/or plan of study by NASA discipline scientists and an external merit review group. OSSA fellows carry out research or a plan of study at their home universities and attend a three-day annual symposium at NASA Headquarters in Washington, D.C. The symposium provides an opportunity for GSRP fellows to exchange ideas, discuss progress, and learn more about space science and applications at NASA. OSSA's research opportunities are described in the Areas of Research section of this book.

The remaining new awards are distributed throughout NASA field centers. Fellows selected by centers must spend some period of time in residence at the center, taking advantage of the unique research facilities of the installation and working with center personnel. The projected use of center expertise and facilities is an important factor, along with academic qualifications and research plans, in the selection of center fellows.

Students applying for a center fellowship are strongly urged to contact the NASA researcher identified at the end of each research description prior to developing a proposal. Students applying to the Headquarters Office of Space Science and Applications may contact Mr. Joseph Alexander's office (see page 12).

## Underrepresented Minority Focus Component

While we have been very pleased with the success of the Graduate Student Researchers Program,we are concerned that few members of underrepresented minority groups are participating. Thus, in 1987, NASA introduced the Underrepresented Minority Focus Component. Applicants must be sponsored by the graduate department chair or faculty advisor. Students selected for the program will collaborate with faculty advisors and with NASA technical officers.

Students selected by NASA field centers must spend a period of residency at the center, taking advantage of the unique research facilities of the installation and working with center personnel. As in the Graduate Student Researchers Program, this period may range from several days to several months and need not be a single continuous time period.

**Note**: Students attending Historically Black Colleges and Universities (HBCU's) are encouraged to apply to the GSRP, but are ineligible for the Underrepresented Minority Focus Component. Graduate students at HBCU's have access to NASA fellowships through other programs between NASA and HBCU's and are directed to these programs sponsored by the NASA Minority University Research and Education Programs Division, Code EU, Office of Equal Opportunity Programs, NASA Headquarters, Washington, DC 20546.

## NASA Graduate Student Fellowships In Global Change Research

NASA established this graduate student training fellowships for persons pursuing a Ph.D. degree in aspects of global change research. The purpose is to ensure a continued supply of high-quality scientists to support rapid growth in the study of Earth as a system. A total of 150 fellowships have been awarded since the inception of the program in 1990. Fifty new fellowships will be available for each of the 1993 and 1994 academic years.

## High Performance Computing and Communications

In the 1993 and 1994 academic years, at least five new GSRP awards will be granted each year as part of the Federal High Performance Computing and Communications (HPCC) Program. HPCC is a multiagency program designed to accelerate the development and application of high performance computing systems through an integrated program of hardware, software, and network development, as well as long term basic research. Within the Federal program, NASA will focus on: aeronautical, Earth science, and space science applications; interagency software coordination; and basic research for future HPCC systems.

# *Summary of NASA Research Areas*

# Summary of NASA Research Areas

## NASA Headquarters Office of Space Science and Applications

Astrophysics
Earth Science
Information Systems
Life Sciences
Microgravity Science and Applications
Solar System Exploration
Space Physics

## Ames Research Center

Advanced Instrumentation
Advanced Life Support
Aeronautics
Aerothermal Materials and Structures
Aerothermodynamics
Aircraft Conceptual Design
Applied Computational Fluid Dynamics
Artificial Intelligence
Atmospheric Physics
Bioregenerative Life Support
Computational Fluid Dynamics
Computational Materials Science
Computer Graphics Workstations
Computer Vision
Control Algorithm for Wind Tunnel Support Systems
Earth Atmospheric Chemistry and Dynamics
Ecosystem Science
Ecosystem Science and Technology
Engineering and Technical Services
Experimental Aerodynamics
Extravehicular Systems Research and Technology Flight Research
High-Speed Computer Architectures
Human Factors
Hypersonics
Infrared Astronomy and Astrophysics
Infrared Astronomy Projects and Technology Development
Intelligence Systems Technology
Neurosciences
Physical-Chemical Closed-Loop Life Support
Planetary Biology
Planetary Science
Rotary Wing Aeromechanics
Rotorcraft Technology
Scientific Visualization and Interactive Computer Graphics

## Ames Research Center (continued)

Search for Extraterrestrial Intelligence
Solar System Exploration
Space Biology
Space Physiology
Space Projects
Spacecraft Data Systems
Telecommunications
Theoretical Astrophysics
Turbulence Physics
Unsteady Viscous Flows
Wind Tunnel Automation
Wind Tunnel Composite Applications

## Dryden Flight Research Facility

Advanced Digital Flight Control
Aircraft Automation
Flight Dynamics
Flight Systems
Flight Test Measurement and Instrumentation
Fluid Mechanics and Physics
Integrated Test Systems and Aircraft Development
Propulsion\Performance
Structural Dynamics

## Goddard Space Flight Center

Atmospheric Chemistry and Dynamics Branch
Atmospheric Experiment Branch
Biogeochemical Cycles
Biospheric Studies
Causes of Long-Term Climate Change
Climate and Radiation Branch
Cryogenics Laboratory
Data Assimilation Office
Data Systems Technology Division
Earth Sciences Directorate
Electromechanical Branch
Engineering Directorate
Environmental Sensors
Experimental Instrumentation
Flight Dynamics Division
Global Change Data Center
Hydrological Sciences Branch
Interdisciplinary Research
Laboratory for Astronomy and Solar Physics
Laboratory for Atmospheres
Laboratory for Extraterrestrial Physics
Laboratory for High Energy

## Goddard Space Flight Center (continued)

Laboratory for Hydrospheric Process
Laboratory for Terrestrial Physics
Microwave Sensors Branch
Mission Operations and Data Systems Directorate
NASA Center for Computational Science
National Space Science Data Center
Observational Science Branch
Oceans and Ice Branch
Optics Laboratory
Photonics Branch
Planetary Atmospheres
Planetary Atmospheres Branch
Robotics Branch
Satellite Data Utilization Office
Science Network Office
SeaWiFS Project
Sensor Concepts and Calibration
Severe Storms Branch
Solid Earth Geophysics
Space Data and Computing Division
Space Geodesy
Thermal Development Laboratory
Tropical Rainfall Measuring Mission (TRMM) Office

## Jet Propulsion Laboratory

Advanced Systems
Advanced Teleoperation and Man-Machine Systems
Asteroid Dynamics
Astrophysics
Autonomous Control and Tracking Systems
Autonomous Mobile Vehicle
Chief Engineer
Control Systems
Data Storage Technology
Defense and Civil Information
Earth and Space Science Division
Earth Atmosphere
Earth Geoscience
Earth Observation Analysis
Electro-optical Tracking Systems
Flight Computers
Flight Projects Interface
Flight Projects Support Office
Flight Support Facilities
Frequency Standards Research
Geodynamics
Gravitational Wave Studies

## Jet Propulsion Laboratory (continued)

Hardware Assurance Division
Image Processing Applications Development
Imaging Systems
Information Systems Division
Information Theory and Coding
Infrared and Analytical Instrument Systems
Institutional Computing and Mission Operations Division
Mechanical and Chemical Systems Division
Microelectronic Device Research
Microwave Observational Systems
Mission Design
Mission Information Systems Engineering
Mission Profile and Sequencing
Navigation Systems
Observational Systems Division
Oceanography
Optical Communication
Optical Sciences and Applications
Planetary Atmospheres
Planetary Atmospheres and Interplanetary Media
Planetary Dynamics
Planetary Radar Astronomy
Planetology
Power Research and Engineering
Process Engineering
Program Control and Administration (PC&A)
Radar Remote Sensing of the Earth
Reliability Engineering
Robot Arm Control
Software Product Assurance
Space Physics
Spacecraft System Engineering
System Integration and Test Quality Assurance
Systems Analysis
Systems Assurance Division
Systems Division

## Johnson Space Center

Advanced Extravehicular (EVA) Systems
Advanced Software Technology
Artificial Intelligence
Biomedical and Nutrition Research
Biotechnology and Bioprocessing
Computer Graphics Research
Endocrine Biochemistry
Environmental Physiology\Biophysics Research
Exercise Physiology

## Johnson Space Center (continued)

Flight Data Systems
Guidance, Navigation, and Control
Immune Responses to Space Flight
Intelligent Robotics
Life Support Systems
Orbital Debris
Pharmacokinetic Research
Physiologic Research
Planetary Materials Analysis
Propulsion and Power
Psychological Research
Regenerative Life Support Systems
Risk Management
Robotic Applications
Robotic Simulation
Space Food Development
Space Radiation
Spacecraft Thermal Management Systems
Technology Development for New Initiatives
Telerobotics and Autonomous Robotic Systems
Tracking and Communications

## Kennedy Space Center

CELSS Research
Earth Sciences Advanced Programs
Engineering Advanced Programs

## Langley Research Center

Advanced Aircraft Systems
Advanced Computational Capability
Advanced Propulsion Technology
Advanced Sensor Systems
Aeroacoustics
Aerobraking
Aerodynamics and Aerothermodynamic Experiments
Analysis and Interpretation of Constituent and Temperature Data for the Middle Atmosphere
Climate Research Program
Computer Science
Configuration Definition for the Evolution of Space Station *Freedom*
Controls and Guidance
Earth Radiation Budget Experiment (ERBE)
Electromagnetics, Antennas, and Microwave Systems
Electronics and Information Systems
Engineering Laboratory Unit

## Langley Research Center (continued)

Entry Fluid Physics
Facilities Engineering
First Lunar Outpost
Fluid Physics
General Aviation
Halogen Occultation Experiment (HALOE)
High-Speed Aircraft
Human Factors
In-Space Technology Experiments
Lunar Rover Robotics Missions
Materials Characterization Technology
Measurement Science and Instrument Technology
Measurements of Air Pollution from Satellites (MAPS)
Propulsion
Space Controls and Guidance
Space Exploration Initiative
Space Systems Technology
Stratospheric Aerosol and Gas Experiment (SAGE)
Structures (Aero)
Structures (Space)
Subsystem Growth Requirements for Space Station *Freedom*
Systems Engineering
Transport Aircraft
Transportation Systems
Tropospheric Chemistry Research Program
Upper Atmospheric Research Program

## Lewis Research Center

Advanced Composite Mechanics
Aerospace Applications of High Temperature Superconductivity
Aircraft Icing
Aircraft Power Transfer Technology
Aircraft Propulsion Systems Analysis
Ceramic-Matrix Composites
Computational Fluid Mechanics
Computational Structures Technology
Computational Technology
Concurrent Engineering Simulation
Controls and Dynamics
Digital Systems Technology
Electrochemical Space and Storage
Emissions Technology
Environmental Durability of Advanced Materials
Experimental Fluid Mechanics
Fan\Propeller Aerodynamics and Acoustics
High Performance Aircraft Propulsion Technology

## Lewis Research Center (continued)

High Performance Computing and Communications\Numerical Propulsion Simulation
High Temperature Electronics Technology
Hypersonic Propulsion Technology
In-Space Technology Experiments
Instrumentation and Sensors
Liquid Rocket Propulsion
Low Noise Nozzle Technology
Low Thrust Propulsion Fundamentals
Metal Matrix and Intermetallic Matrix Composites
Microgravity Materials Science
Microgravity Science and Applications
MMIC Technology
Molecular Computational Fluid Dynamics
Phased Array Antenna Technology
Photovoltaic Space Systems
Polymers and Polymer Matrix Composites
Power Materials Technology
Power Systems Technology
Probabilistic Structural Mechanics
Rocket Engine System Monitoring
Solar Dynamic Systems for Space Power
Space Communications Systems Analysis
Space Environmental Interactions
Space Power Management and Distribution Technology
Stirling Dynamic Power Systems
Structural Analysis and Life Prediction
Structural Dynamics
Structural Integrity
Thermal Management Technologies for Space Power Systems
Tribiology
Turbine Engine Technology
Vacuum Electronics

## Marshall Space Flight Center

Aeronomy
Atmosphere\Land Surface Interface
Audio Systems
Biophysics
Climate Modeling with the CMI
Cloud Scattering of Lightning Discharges
Combustion Devices and Turbomachinery
Communications Systems
Component Development Division
Computational Fluid Dynamics
Configuration Management
Control Mechanisms

## Marshall Space Flight Center (continued)

Controls for Vehicles
Cosmic Ray Research
Cryogenic Physics
Crystal Growth in Fluid Field and Particle Dynamic Evaluation
Docking\Berthing Sensors
Electrical Systems
Electronics, Sensors, Robotics
Engineering Graphics Workstation
Gamma Ray Astronomy
Geophysical Fluid Dynamics and Modeling
Hypervelocity Impact Design and Analysis
Infrared Astronomy
Liquid Propulsion Dynamic Analysis
Low Gravity Science
Magnetospheric and Plasma Physics
Materials and Processes Laboratory
Metallic Materials
Mission Operations Laboratory
Model Studies of Storm Electrical Processes
Nonmetallic Materials Research
Optical Systems
Physical Climate Analysis
Pointing Control Systems
Process Engineering Research
Propulsion Laboratory
Quality Engineering
Reliability Engineering
Software Data Management
Solar Physics
Space Environmental Effects on Materials
Space Vehicle Environments
Stratospheric and Mesospheric Studies
Structural Assessment: Structural Analysis
Structural Design
Structural Dynamics
Surface Properties\Atmospheric Boundaries Interactions
Systems and Components Test and Simulation
Systems Division
Systems Safety Engineering
Test Division
Thermal Analysis: Liquid Propulsion Systems
Thermal Analysis: Solid Rocket Motor
Thermal\Environmental Computational Analysis
Tropospheric Wind Profiling
Vibroacoustics
X-ray Astronomy

## Stennis Space Center

Active and Passive Nonintrusive Remote Sensing of Propulsion Test Parameters
Advanced Propulsion Systems Testing
Application of Parallel Computing to Data Analysis
Artificial Intelligence (AI) Capability for Intelligent Processing of Remotely Sensed and Propulsion Test Data
Computational Modeling and Simulation
Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultra High Pressure Fluid Systems
Earth Observation Technology
Environmental Impact from Propulsion System Testing
Ground Test Facilities Technology
Leak Detection, Sensors, Quantification and Visualization
LOX\GOX Compatible Materials
Material and Fluid Science
Nondestructive Test and Evaluation
Propellant and Pressurants Conservation, Recycling, and Energy Conservation Leak Detection, Sensors, Quantification, and Visualization
Propulsion System Testing Techniques, Simulation, Modeling, and Methodologies
Propulsion Test Data Acquisition Systems
Spectroscopy Technology for Propulsion System Testing
Thermal Protection and Insulation Systems
Use of Visualization Technologies for SSC Data Analysis
Vehicle Health Management\Rocket Exhaust Plume Diagnostics
Visual Data Analysis

*NASA*
*Graduate*
*Students*
*Researchers*
*Program*
*Administrators*

# Graduate Student Researchers Program Administrators

The NASA Graduate Student Researchers Program (GSRP) is managed at the national level by the Higher Education Branch, Education Division, Office of Human Resources and Education, Code FEH, NASA Headquarters, Washington, DC 20546

Elaine T. Schwartz
Branch Chief

John T. Lynch
GSRP/UMF Program Manager
Phone (202) 358-1531
FAX (202) 358-3048

The Office of Space Science and Applications (OSSA) at NASA Headquarters and NASA field centers around the United States participate in the program. Local Program Administrators are:

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**Office of Space Science and Applications, Code S**
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FAX (415) 604-3622

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# *Administrative Procedures*

# Administrative Procedures

**Selection of Proposals —** Graduate students are selected for participation in this program by NASA Headquarters, individual NASA centers, or by the Jet Propulsion Laboratory for participation on the basis of (a) the academic qualifications of the student; (b) the quality of the proposed research or plan of study and its relevance to NASA's programs; (c) except at NASA Headquarters, the student's proposed utilization of Center research facilities; and (d) the ability of the student to accomplish the defined research.

**Awards —** Fellowships are made initially for a period of one year and may be renewed annually for a total of three years, based on satisfactory progress as reflected in performance evaluations by the faculty advisor. Renewals must also be approved by NASA installation Program Administrators and technical supervisors.

**Eligibility —** Full-time (as defined by the university) graduate students enrolled in an accredited U.S. college or university are the only persons eligible for program awards. They must be citizens of the United States. Students may enter the program at any time during their graduate work or may apply prior to receiving their baccalaureate degrees. All applications must be sponsored by the student's graduate department chair or faculty advisor. Those selected will usually receive support until they receive an advanced degree, a maximum of three years in most cases. An individual accepting this award may not concurrently receive other Federal fellowships or traineeships.

Students from underrepresented minority groups who apply to this program may also apply to the Underrepresented Minority Focus Component (see Section III).

**Equal Opportunity —** No applicant shall be denied consideration or appointment as a NASA Graduate Student Researcher on grounds of race, creed, color, national origin, age, or sex.

**Obligation to the Government —** A student receiving support under the Graduate Student Researchers Program does not thereby incur any formal obligation to the Government of the United States. However, the objectives of this program will clearly be served best if the student is encouraged to actively pursue research or teaching in aeronautics, space science, or space technology after completion of graduate studies.

**Funding —** The total annual award per graduate student cannot exceed $22,000. In addition to the $16,000 student stipend, an allowance of $6,000 ($3,000 for the student allowance and $3,000 for the university allowance) may be requested to help defray tuition costs or to provide a per diem and travel allowance for the student and faculty advisor. Students participating in the Headquarters OSSA program should plan to attend, along with their advisors, a three day symposium in Washington, D.C., in the spring of each year. Specific details regarding this conference will be communicated after awards have been made.

The student allowance may also be used to help defray living expenses during periods of center residency. Students currently living close to the center to which they apply should request only a nominal amount for this purpose.

The university allowance may be used by the faculty advisor for supervision of the student's work and for travel to the NASA facility to oversee the student's progress. It may also be used for student tuition. Alternative uses for this allowance may be requested but must be consistent with the intent of the program.

New grant applicants attending GSRP workshops/symposiums prior to their grant start date may be reimbursed for travel expenses. The use of training grant funds for purchasing nonexpendable equipment is prohibited.

**Equipment —** The use of training grant funds for the purchase of nonexpendable equipment is prohibited.

**Disposition of Unused Funds —** If a student terminates the GSRP earlier than anticipated, the student stipend is prorated and terminated (see Replacement Student section below). Any unused student/university allowances are returned to NASA. Renewal applicants who have funds remaining from their previous year's budget may carry the remaining funds over into the following program year.

**Foreign Travel —** All travel outside the United States must clearly be essential to the research effort and, to be charged to a grant, have prior approval of the GSRP Manager and Grants Officer for each specific trip regardless of its inclusion in the proposed budget. A written request must state the purpose, cost and travel dates, and include the NASA fellowship number.

**Replacement Student —** If a student ceases to participate in the program for any reason, the university, with prior NASA Headquarters approval, may appoint another student with similar research objectives to complete only the remaining portion of the current year. Students electing to apply for the following program year are not automatically entitled to

award and are subject to the evaluation and selection procedures administered to new applicants.

**Internal Revenue Service —** All questions concerning taxes should be directed to the Internal Revenue Service. Refer to IRS Publication 520 titled "Scholarships and Fellowships," and Publication 508 titled "Educational Expenses."

**Final Administrative Report —** It is the responsibility of the institution receiving a NASA fellowship to ensure the final report on the fellow's research and academic progress is submitted no later than 90 days after the termination date of the award. Information to be furnished includes the degree granted, important results of the student's experiences (e.g., thesis title, papers published other than thesis, presentations made, awards, honors), and employment or other future plans. This report should be submitted to:

**GSRP Administrator**
**Higher Education Branch**
**Code FEH**
**National Aeronautics and Space Administration**
**300 E Street, SW**
**Washington, DC 20546**

A copy must also be sent to the appropriate NASA Installation Program Administrator, and the NASA Headquarters Acquisition Division, Code HWG. NASA Graduate Student Researchers fellowships are subject to the provisions of 14 CFR 1265, Government-wide Debarment and Suspension.

**Student Evaluation Forms —** Students completing their last year in the program will be mailed an evaluation form 60 days prior to termination date. These forms must be completed and returned to the appropriate NASA Program Administrator. Students with approved no-cost extensions should return completed forms at the time of fellowship termination. If you do not receive the evaluation form, contact the appropriate Program Administrator.
**NOTE**: This form is not intended to be used in lieu of the final administrative report.

**Inquiries —** Questions concerning the preparation and submission of proposals and the administration of this program are to be directed to the Program Administrators listed on page 12.

**Special Note to NASA Graduate Fellows:** For over a decade NASA has had the unique opportunity to offer fellowships in aeronautics, space science, space applications, and space technology to promising graduate students nationwide. A vital component of continued support for the Graduate Student Researchers Programs is contributed by you, the student, with the submission of the final administrative report and student evaluation. Program objectives are measured and funding levels are set as a result of these reports.

# *Preparation and Submission of Proposal*

# Preparation of Proposal

**Unsolicited Proposal Requirements** — Proposals must be written by the student. All proposals must be specific in nature and must be assembled in the order listed in the following seven categories.

**1. Proposal Cover Sheet** — This page is to be filled out and signed by the student, faculty advisor, and university official responsible for committing the institution for sponsored research. At least one (1) complete proposal package must contain ***original*** signatures. Cover sheets appear in the back of this section.

**2. Abstract/Description of Proposed Research and/or Plan of Study** — On a separate page, include a summary describing the objectives of the plan of study and/or the proposed research and the methodology to be used. Students should prepare a full statement that identifies and relates the key elements of the proposed research and/or plan of study. Include the proposed starting and completion dates for the graduate student's plan of study and/or research program; the approximate periods the student and faculty advisor expect to be at the NASA center to conduct activities, if applicable; and a detailed schedule and plan in all new proposals. The length should not exceed five single-spaced pages.

**3. Letter of Recommendation** — The faculty advisor should prepare and sign a one page letter of recommendation on behalf of the student.

**4. Facilities and Resources (Center Applicants Only)** Students should describe the NASA facilities and resources he/she wishes to use in support of the research and/or plan of study, including an estimate of any computer time required. Students are strongly encouraged to contact the appropriate facility technical advisor to coordinate research activities.

**5. Personnel** — The faculty advisor must submit a short biographical sketch that includes name, current position, title, department, university address, phone number, and principal publications. The student is required to submit a transcript of grades and a summary of education, training, awards, scholarships, significant accomplishments, and any other relevant information.

**6. Budget** — A twelve-month budget must include the following: (a) student stipend - $16,000 basic stipend for twelve months; (b) student allowance - $3,000. Cost estimates for tuition expenses and/or anticipated travel and living expenses for the student at a NASA facility; and (c) university allowance - $3,000. Cost estimates for travel of faculty advisor to a NASA facility to coordinate and oversee the work of the graduate student. If necessary, student tuition may also be charged against this allowance.
**Note:** The use of training grant funds for the purchase of nonexpendable equipment is prohibited.

**7. Approval** — Approval of proposed research and/or plan of study by (1) faculty advisor; and (2) the university official responsible for committing the institution for sponsored research (e.g., Director of Research Administrator, Director of Sponsored Research). Proposals are not processed without the appropriate university approval signatures. Telephone numbers must be included for each approving individual.

**Note:** This booklet should be used for both the 1993 and 1994 graduate programs. Please retain copies of the application form for future submissions.

# Submission of Proposal

All applicants must submit one original and nine (9) copies of all materials by **February 1** of each year to the appropriate NASA facility, addressed to the attention of the Program Administrator listed in the Program Management and Administration section of this book.

Headquarters OSSA proposals should be submitted to:

**Graduate Student Researchers Program**
**Code SPM-20**
**NASA Headquarters**
**300 E Street, SW**
**Washington, DC 20546**

Applications will be reviewed in February of each year for selection in March and April. Proposed starting dates for new awards will be July 1 or after. In general, tenure will begin with normal semester or quarter dates.

**Multiple Submissions —** When submitting to more than one NASA facility or to the Graduate Student Researchers Program (GSRP), the Underrepresented Minority Focus (UMF) program, and the High Performance Computing and Communications (HPCC) program, separate *original* application forms, and all required information, including the number of copies necessary to evaluate the proposal, must accompany each submission. A faxed proposal will not be considered valid and, therefore, will not be reviewed.

**Renewal Applications —** Proposals for renewal are to be submitted to the appropriate Program Administrator by **February 1.** All applicants should submit an original and nine (9) copies of all materials. The proposal for renewal should include items 1, 6, and 7 in the Preparation of Proposal section of this book on page 18, as well as a brief statement (approximately one page) by the student outlining his or her progress on the research or plan of study. Also included in the renewal package should be a transcript of the student's grades during the preceding year and a one-page evaluation and recommendation signed by the faculty advisor. Proposals will not be renewed without this information. The starting date for renewals should be on the anniversary of the original grant.

**Sponsored Research Office —** When submitting applications for new or renewal fellowship awards, please include the name, address, and telephone number of the university official responsible for committing the institution for sponsored research (e.g., Director of Research Administration, Director of Sponsored Research).

***All application packages must include certifications to debarment and suspension and the drug-free workplace certification.***

# PROPOSALS DUE FEBRUARY 1

*NASA Graduate Student Researchers Program Proposal Cover Sheet*

## I. Student Information

Name: (Mr/Ms)

Last First MI

Birth Date: _____

Birthplace: _____

Home Address: _____

_____

Home Phone: _____

Target Degree: __ MS __ MS/PhD (Joint) __ PhD

Discipline: _____

Department: _____

Campus Address: _____

Mail Code: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____ Fax No.: _____

E-Mail: _____

Undergraduate GPA : _____ Out Of _____

Discipline: _____

Graduate GPA (If Applicable): _____ Out Of _____

Discipline: _____

*I certify that I am a citizen of the United States and that I am or will be a full-time graduate student at the university during the period covered in this proposal.*

*Signature:* _____ *Date:* _____

## II. Faculty Advisor Information

Name: _____

Department: _____

Campus Address: _____

Mail Code: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

Fax Number: _____

E-Mail: _____

*Signature:* _____ *Date:* _____

## III. Official Responsible for Committing Institution

Name: _____

Title: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

*Signature:* _____ *Date:* _____

## IV. Proposal Information

Type of Proposal:

☐ (1) New ☐ (2) Second Year ☐ (3) Third Year *If Renewal, Designate Grant No.:* **NGT-** _____

Proposed Start or Renewal Date: _____ Expected Completion Date: _____

Proposal Title: _____

_____

## V. Submission Information

☐ Headquarters

__ Life Sciences
__ Earth Sciences
__ Solar System Exploration
__ Information Systems
__ Microgravity
__ Space Physics
__ Astrophysics

☐ NASA Centers

__ Ames/Dryden (ARC/DFRF)
__ Goddard (GSFC)
__ Johnson (JSC)
__ Jet Propulsion Lab (JPL)
__ Kennedy (KSC)
__ Langley (LaRC)
__ Lewis (LeRC)
__ Marshall (MSFC)
__ Stennis (SSC)

Center Technical Advisor:

_____

Other Facilities to which this proposal is being submitted:

_____

## VI. Proposal Checklist

☐ Original and 9 Copies

☐ Original Transcripts

☐ Signed Advisor Evaluation

☐ Budget Form

☐ University Certifications
- Suspension and Debarment
- Drug Free Workplace

## *VII. NASA Use Only*

☐ Org/Cpys

☐ OT

☐ SAE

☐ BdgtFrm

☐ UCert

☐ Returned Proposal

_____

_____

In order to determine the degree to which members of each ethnic/racial group are reached by this announcement, NASA requests that the student check the appropriate block(s). Submission of this information is voluntary.

☐ AMERICAN INDIAN ☐ ASIAN* ☐ BLACK

☐ HISPANIC ☐ PACIFIC ISLANDER** ☐ WHITE

☐ INDIVIDUAL WITH DISABILITIES ***

☐ MALE

☐ FEMALE

*This area includes, for example, China, India, Japan and Korea.

**This area includes any of the original peoples of Hawaii; the U.S. Pacific Territories of Guam, American Samoa, and the Northern Marianas, the U.S. Trust Territory of Palau; the Islands of Micronesia and Melanesia; and the Philippines.

***A disability that limits a major life activity.

# NASA Graduate Student Researchers Program
# Budget Information

**I. Student Stipend** (Maximum of $16,000) $_____

**II. Student Allowance** (Itemize if necessary)

Student Allowance Total $_____
(Maximum of $3,000)

**III. University Allowance** (Itemize if necessary)

University Allowance Total $_____
(Maximum of $3,000)

***Total Requested*** **$**_____
(Maximum of $22,000)

# *Section II —*

# *NASA Graduate Student Researchers Program*

## *Areas of Research Activities at NASA Facilities*

# *NASA Office of Space Science and Applications*

*Program Administrator:*
*Mr. Joseph K. Alexander*
*Assistant Associate Administrator (Science and Applications)*
*Office of Space Science and Applications, Code S*
*National Aeronautics and Space Administration*
*Washington, DC 20546*
*(202) 358-1430*

*For inquiries contact:*
*Dolores Holland*
*(202) 358-0734*

*Mail NASA Headquarters proposals to:*
*Graduate Student Researchers Program*
*Code SPM-20*
*NASA Headquarters*
*300 E Street, SW*
*Washington, DC 20546*

***The NASA Headquarters Office of Space Science and Applications (OSSA) supports basic and applied research in space science. The OSSA research program includes the development of major space flight missions such as the Compton Gamma Ray Observatory and the Upper Atmosphere Research Satellite, complementary laboratory research and analysis of data from prior missions, and theoretical studies. The scientific disciplines currently being supported are astrophysics, solar system exploration, space physics, Earth science, microgravity science and applications, life science, and information systems. A brief description of these programs follows.***

**Astrophysics** — Research in astrophysics involves a broad program of space-based observations with limited support from ground-based astronomy. Extraterrestrial objects are observed across the electromagnetic spectrum, from gamma-ray to radio wavelengths. Research in relativity and gravitational-wave physics is also supported. Research in laboratory and theoretical astrophysics is also conducted to aid in the interpretation of these observations. New instrument development for astrophysical research with airplane, balloon, and sounding rocket payloads is also supported.

**Solar System Exploration** — Solar system research is aimed at understanding the origin, evolution, and present state of the solar system through astronomical observations, laboratory experiments, data analysis, and modeling. Areas of emphasis include the study of planets, rings, moons, asteroids, and comets; analysis of meteorites, cosmic dust, and lunar samples; astronomical studies spanning the spectrum; and the search for other planets. Data analyses include Viking, Voyager, Magellan, Galileo, and ground- and space-based telescopic data.

**Space Physics** — The space physics program involves investigations of the origin and evolution of plasmas, electromagnetic fields, and energetic particles in space. The studies focus on the Sun, both as a star and as a source of energy, plasma, and energetic particles; on the heliosphere, both in steady state and dynamic configurations; on planetary and cometary thermospheres, ionospheres, and magnetospheres; and on the acceleration and propagation of the solar wind and of solar and galactic cosmic rays. Measurements are made from stratospheric balloons, sounding rockets, Earth-orbiting satellites, and deep space probes. Theory and computer simulations are used to synthesize these measurements into the general understanding of space physics phenomena.

**Earth Science** — Earth science and applications involves an interdisciplinary program of research to study the physical and biological processes that govern the Earth system, its oceans and atmosphere, and its biosphere. Emphasis is placed on understanding how the Earth functions as a system and how it affects and is affected by global change. The program involves coordinated observational modeling and experimental investigations that together form a balanced program of system and process studies. The

observational investigations use both *in situ* measurements and remote sensing. Instruments fly on aircraft, balloons, rockets, orbiting spacecraft, and the Space Shuttle.

**Microgravity Science and Applications** — The objective of the Microgravity Science and Applications Program is to explore and understand the effects of microgravity on physical and chemical processes and phenomena. The program emphasizes three areas: fundamental science, materials science, and biotechnology. Fundamental science research includes the study of fluid behavior and transport phenomena, combustion science, as well as experiments that enable scientists to study and challenge theories of gravitational physics. Research in materials science includes the processing and characterization of electronic and photonic materials; metals, alloys, and composites; glasses and ceramics; and polymers. Areas of emphasis in biotechnology include macromolecular crystal growth, separations processes, and cell culture. Investigations are conducted by using both ground-based and flight experiments.

**Life Sciences** — Research in the life sciences involves a multi-disciplinary approach in the medical and biomedical sciences. Research focuses on medical care; space physiology and countermeasures; radiation health; environmental health; human factors; biologically based life support systems; the origin, evolution, and distribution of life in the universe (exobiology); and the effect of the space environment on living things (space biology). The program includes ground-based research and the flight of equipment and instruments for human, animal, plant, and cellular experiments on board the Space Shuttle, in the Spacelab laboratory module, and on other Earth-orbiting spacecraft. Proposals that require human or animal subjects must contain a statement from the proposer's institution that the proposed work will meet all Federal and local human-subject requirements and animal care and use requirements. Policies regarding protection of human research subjects in NASA-sponsored research are detailed in NASA Management Instruction (NMI) 7100.8B, "Protection of Human Research Subjects." Animal care and use requirements are detailed in NMI 8910.1, "Care and Use of Animals in the Conduct of NASA Activities." Both are available from the Life Sciences Division, Code SB, NASA Headquarters, Washington, DC 20546.

**Information Systems** — Information systems research focuses on providing new capabilities for data archives and directories, computer networking, and high-performance computing in support of space science. The program includes development of genetic tools and capabilities, testbed efforts to demonstrate and evaluate advanced technologies for NASA, technology demonstrations, and research efforts in areas such as graphics and visualization, algorithms, data storage technologies, and access methods as applied to space science.

# *Ames Research Center*

*Program Administrator:*
*Ms. Meredith Moore*
*Mail Stop 241-3*
*NASA Ames Research Center*
*Moffett Field, CA 94035*
*(415) 604-5624*

*The Ames Research Center conducts research activities, technology programs, and flight projects that advance the nation's capabilities in civilian military aeronautics, space sciences, and space applications. This diverse program at Ames is organized into aeronautics, aerophysics, space research, and life sciences.*

*In preparing a proposal for a fellowship at Ames Research Center, prior collaboration with an Ames researcher is mandatory. A suggested point of contact is listed with each research topic for which a student may apply.*

**Aeronautics —** In aeronautics, Ames concentrates on rotorcraft and powered lift aircraft technology, short-haul aircraft and helicopter technology, fluid mechanics, experimental aerodynamics, flight simulation, flight systems research, and human factors.
Contact: Don Ehrreich
(415) 604-5067

**Experimental Aerodynamics —** Low-speed testing in the 12x24-, 24x37-, and 2x3-meter wind tunnels. Development of computational/empirical prediction methods for powered lift and conventional lift configurations. Prediction and analysis of acoustic characteristics of aircraft configurations and wind tunnel facilities. Development and application of nonintrusive measurement techniques.
Contact: Dennis Riddle
(415) 604-6677

**Computer Vision —** Computer vision and image understanding techniques are being applied to the autonomous navigation of rotorcraft during low-altitude flight. The techniques are quite general and can be used in the autonomous guidance of other types of vehicles.
Contact: Banavar Sridar
(415) 604-5450

**Flight Research —** Simulation investigations, guidance and navigation, aircraft automation, flight dynamics, advanced control theory (helicopter V/STOL applications).
Contact: Dallas Denery
(415) 604-5427
Guidance & Navigation Automation Research

Vic Lebacqz
(415) 604-5009
Flight Dynamics and Controls Research

**Human Factors —** Crew performance, aviation safety, aircraft operating systems, advanced spatial displays and instruments, virtual environments, high-fidelity simulation-based human performance assessment, operator interfaces to intelligent systems and advanced automation.
Contact: Mike Shafto
(415) 604-6170

**Rotorcraft Technology —** Rotorcraft development; wind tunnel, simulation and flight test experiments, identification of advanced rotorcraft concepts, technology, and systems integration.
Contact: Bill Snyder
(415) 604-6570

**Aircraft Conceptual Design —** Development of aircraft design synthesis techniques that incorporate optimization routines, expert system concepts, and graphical user interfaces on a system of networked computer workstations. Studies are broad in nature, encompassing the subsonic to hypersonic speed ranges, and including such concepts as rotorcraft, fix-wing, and transatmospheric vehicles. Analyses include a total transportation systems approach and consider markets and economics.
Contact: Thomas L. Galloway
(415) 604-6181

**Rotary Wing Aeromechanics —** Experimental and theoretical research programs to improve performance, vibration, and noise of advanced rotorcraft are performed. Studies include basic investigations of the aerodynamics, dynamics, and acoustics of rotor systems for helicopters, tilt rotors, and other advanced configurations. Experiments are performed in the Ames 2x3-meter wind tunnel and in the National Full-Scale Aerodynamics Complex, including the 12x24-meter wind tunnel.
Contact: William Warmbrodt
(415) 604-5642

**Engineering and Technical Services** — In engineering and technical services, Ames concentrates on facility engineering, telecommunications, and administrative computing.
Contact: Jim Hart
(415) 604-6251

**Telecommunications** — Engineering and advanced systems capability for voice, video, data communications, computer networking, and networking research.
Contact: Jim Hart
(415) 604-6251

## Aerophysics

**Artificial Intelligence** — Basic and applied research is conducted in the framework of aerospace domains including Space Station *Freedom*, space science applications, and the proposed Space Exploration Initiative and National Aerospace Plane. Three research areas are emphasized: planning (including both goal- and resource-driven approaches), machine learning (the entire spectrum from empirical to knowledge-intensive), and the design of and reasoning about large-scale physical systems (including work in knowledge acquisition, knowledge base maintenance, and AI applications to the design process).
Contact: Peter Friedland
(415) 604-4277

**Intelligent Systems Technology** — Research is conducted in intelligent computational systems for aerospace missions. Activities address autonomous operation, evolutionary capability, real-time performance, and adaptivity. Current research programs include parallel systems, fault management, open computer architectures, analog optical processors for pattern recognition and control tasks, and neural networks. There is also an emphasis on integrating technologies into advanced distributed, heterogeneous systems and developing tools for performance evaluation.
Contact: Charles Jorgensen
(415) 604-6725

**Aerothermodynamics** — Provides aerothermodynamic flow-field computational capability to analyze and design advanced space transportation concepts. Also provides the analytical and turbulence chemistry models required to compute the viscous/finite-rate flow field and to predict radiation heating to conceptual aeroassisted orbital vehicles.
Contact: George S. Deiwert
(415) 604-6198

**Aerothermal Materials and Structures** — Develops lightweight reusable ceramics and carbon-carbon Thermal Protection Systems (TPS) for transient, high-velocity atmospheric penetration and develops expendable TPS for planetary probes.
Contact: Howard E. Goldstein
(415) 604-6103

**Computational Materials Science** — Develops verified methods for predicting material properties and reactions by extending interaction models of interatomic and molecular behavior to the macroscopic level.
Contact: Steven R. Langhoff
(415) 604-6213

**High-Speed Computer Architectures** — Current advances in high-speed computation are coming from novel computer architectures such as parallel processors, data flow architectures, and systolic arrays. The suitability of these architectures to solving problems of interest to NASA and the development of new architectures that efficiently solve these problems is the objective of this research. Of particular interest is the investigation of architectures to solve problems arising in computational fluid dynamics as governed by the Naiver-Stokes equations. These investigations could include software issues as well as hardware issues because the ultimate goal is to provide the researcher at Ames with improved computational resources. Current computational resources include a CRAY2, CRAY Y-MP/8128, iPSC/860, and Connection Machine 2, as well as numerous superminis and workstations.
Contact: Kenneth Stevens, Jr.
(415) 604-5959

**Scientific Visualization and Interactive Computer Graphics** — This research is aimed at the creation of a highly interactive and visual environment for scientists who are developing computer simulations of physics or who are required to analyze large 3-D datasets. Current research is being done using Silicon Graphics Workstations connected to supercomputers.
Contact: Val Watson
(415) 604-6421

**Spacecraft Data Systems** — Research, development, and application of advanced technologies for aerospace computer systems. The data systems technologies selected for development and demonstration are those that have a high impact in supporting known application requirements. Current areas of emphasis include Space Station *Freedom* systems engineering and analysis, evolution and growth studies, payload computer architectures, diagnostics and monitoring systems, portable computer technology, studies of multiprocessor operating system performance, and open computer system architectures.
Contact: Alan Fernquist
(415) 604-5746

**Wind Tunnel Automation** — To support an automation project encompassing the automatic control of model positioning, Mach number, Reynolds number, and system safety monitoring, a computer model of the wind tunnel circuit response to

various inputs is needed. The model must be generic in structure with easily tailored modules to achieve the required specificity. The task will include surveying industry for applicable programs before full development is undertaken. The code will allow the user to input the dynamic response of various inputs (i.e., rotal pressure, drive system, model positioning).
Contact: Daniel Petroff
(415) 604-5850

**Wind Tunnel Composite Applications** — Transfer to composite technology to specific application for the Aerodynamics Division wind tunnels. Areas of application include: axial flow compressor blading, gaging for model support assemblies, and siting assemblies for model supports. Research opportunity exists to develop a computer design code for evaluating and tailoring composite structures to the specific application. Opportunity also exists in developing fabrication and QA techniques.
Contact: Daniel Petroff
(415) 604-5850

**Control Algorithm for Wind Tunnel Support Systems** — Develop and verify the control algorithm and software for a six-degree-of-freedom Captive Trajectory System. The system will be used in wind tunnel testing to evaluate the aerodynamics of separating vehicles. The task involves using existing support systems to accurately and safely position the vehicles for acquisition of data, specifying the control hardware, writing the software, and verifying the software.
Contact: Daniel Petroff
(415) 604-5850

**Computational Fluid Dynamics** — Theoretical research in fluid dynamics using the Euler and the Navier-Stokes equations, both compressible and incompressible. Includes research on basic equation formulations, algorithm development, and code efficiency, as well as the physics of laminar and turbulent flow fields.
Contact: Thomas H. Pulliam
(415) 604-6417

**Turbulence Physics** — Study of the fundamental physics of turbulent and transitional flows through numerical simulations. Studies include developing numerical algorithms suitable for direct and large-eddy simulations of turbulent flows, developing tools for analyzing computer-generated databases, and developing turbulence models for engineering applications.
Contact: John Kim
(415) 604-5867

**Computer Graphics Workstations** — High-performance computer graphics workstations applied to the visualization and understanding of both experimental aerodynamic flow fields and computer-generated solutions of aerodynamic flow fields.
Contact: Val Watson
(415) 604-6421

**Advanced Instrumentation** — Instrumentation techniques are being developed to measure both mean and fluctuating quantities in complex turbulent flow fields. These include three-dimensional LDV systems, rapid scanning LDV systems, multiple hot wire arrays for spatial and time-dependent data, and holography and methods to measure surface skin friction.
Contact: Joseph G. Marvin
(415) 604-5390

**Unsteady Viscous Flows** — Research areas under investigation include dynamic stall control, drag reduction on airfoils and wings, and the control of supersonic transition. Experimental, computational, and theoretical tools are developed and used in both basic and applied studies.
Contact: Sanford Davis
(415) 604-4197

**Applied Computational Fluid Dynamics** — This area deals with the development of new computational methodology involving aerodynamic and/or fluid dynamic applications associated with incompressible, subsonic, transonic, supersonic, or hypersonic flight speeds. Computer codes are constructed and evaluated for applications associated with aircraft or aircraft component aerodynamics, rotorcraft aerodynamics, high angle-of-attack flows, unsteady flows, and flows with aeroelastic effects.
Contact: Terry L. Holst
(415) 604-6032

**Hypersonics** — This area deals with the development of new computational methodology involving aerodynamic and/or fluid dynamic applications associated with hypersonic flight speeds. The physical aspects of this flight regime require emphasis on algorithms/codes with accurate heat transfer prediction capabilities, strong shock capturing abilities and chemical equilibrium and nonequilibrium models for air.
Contact: Thomas A. Edwards
(415) 604-4465

## Space Sciences

In space science, Ames concentrates on research directed at enhancing understanding of the origins, evolution, current state of the universe, the solar system, the Earth, and life. Principle efforts focus on a multidisciplinary approach to research activities in space science and life science. As a federal research laboratory with strong ties to the universities and other government laboratories, Ames brings to the task a small research team approach that applies the skills and interests of the broader science community to these fundamental issues. Particular emphasis in space science is placed on infrared science and climatology, Earth airborne sciences, and the

development and application of selected flight projects and areas of space technology relevant to those research needs. The following are ongoing areas of space science research.

**Infrared Astronomy and Astrophysics —** Properties of solar system, galactic, and extragalactic objects using their infrared spectra to determine constituents and processes. Development of instrumentation for observations from ground sites and airborne and spaceborne platforms. Conducts laboratory research in support of this science.
Contact: Fred Witteborn
(415) 604-5520

**Infrared Astronomy Projects and Technology Development —** Development is conducted for the Stratospheric Observatory for Infrared Astronomy (SOFIA). Current research is focused on the integration of the design tools to allow full system simulation prior to SOFIA operation. The technology tasks include optics, detectors, and cryogenics. Advanced mirror materials are studied in a unique low-temperature facility. Multi-element IR detector arrays are developed and characterized for space astronomy. Advanced efficiency cooling techniques are developed for space.
Contact: Gary Thorley
(415) 604-5917

Craig McCreight
(415) 604-6549

**Theoretical Astrophysics —** Star formation, protostellar disks, galactic formulation and interaction, interstellar grains, planetary formation, planetary atmospheres, radiative transfer, and computational astrophysics and atmospherics to model these processes are but a few of the research issues here.
Contact: Pat Cassen
(415) 694-5547

**Space Projects —** Development of systems and scientific instrumentation with which to explore space and to study biological effects of weightlessness. This includes development of a biological research capability with plants and animals on Space Station *Freedom*, development of instrumentation to be used on interplanetary flights and atmospheric penetrations, management of the ongoing flights of Galileo's Probe to Jupiter's atmosphere, of the Pioneer Venus Orbiter about its planet, and of the Pioneers 10 and 11 departing the solar system, and the study and advocacy of scientific instrumentation for future spacecraft.

**Planetary Science —** Research in this area includes atmospheric chemical, radiative, and dynamic models, remote sensing of planetary atmospheres, planet formation models, and the study of planetary ring dynamics.
Contact: Pat Cassen
(415) 604-5597

## Life Sciences

In life sciences, Ames concentrates on biomedicine (the effects of the space environment on man and other organisms), extraterrestrial research, and biosystems (the ability to support man in the space environment).

**Advanced Life Support —** Advanced Life Support at Ames concentrates on the research and the development of technologies required to support human life in space on long duration missions, for example, transits to Mars and the establishment of bases on the Moon and Mars. The focuses of the work are on technologies for regeneration of life support materials (water, air, and food) through both physical-chemical and bioregenerative processes, and on new concepts in space suits and personal life support systems. The programs have strong ties to universities and industry, and utilize a multidisciplinary approach to scientific, engineering, and development issues.
Contact: William Berry
(415) 604-4930

**Physical-Chemical Closed-Loop Life Support —** Physical-chemical life support includes modeling and simulation, system analysis, and the development of devices and test-beds. Subsystems studied include those for: 1) air regeneration, including $CO_2$ removal and reduction, and water electrolysis; 2) waste management and processing, including waste stream separation and various methods of waste oxidation, including incineration, wet oxidation, and super-critical water oxidation; 3) water purification and regeneration; and 4) atmospheric contamination removal and control.
Contact: Theodore Wydeven
(415) 604-5738

Edwin Force
(415) 604-3755

**Bioregenerative Life Support —** The focus of the bioregenerative life support area is on the use of plants and algae as processors and producers of regenerated air, water, and food in the space environment. Areas stressed include: 1) identification of environmental conditions required for maximal crop plant productivity; 2) development of biological methods for waste water treatment; 3) modeling, simulation, and control of system operation; 4) development of flight hardware for evaluation and qualification of crop productivity in space; and 5) application of technologies to develop devices for astronauts' diet enhancement.
Contact: Robert MacElroy
(415) 604-5573

David Bubenheim
(415) 604-3209

**Extravehicular Systems Research and Technology** — The program primarily focuses on manned systems for advanced zero-g, lunar, and Mars exploration. Elements include: pressure suit, gloves, portable life support, and control/display interfaces with telerobotic EVA work aids. Technology development is required in environmental control systems, controls and displays, suit mobility joints and materials, and in diagnostics, maintenance, and checkout support systems. Advances are required to enable safe, routine, and highly productive manned EVA on future missions.
Contact: Bruce Webbon
(415) 604-6646

**Space Biology** — Space biology research uses the space environment, particularly weightlessness, and ground-based space flight simulations to investigate basic scientific questions about the role of gravity in present-day terrestrial biology and the role it has played during the evolution of living systems. The research is divided into the disciplinary areas of biological adaptation, gravity sensing, and developmental biology. Experiments are carried out at the subcellular, cellular, tissue, organ, and system levels in differing organisms of the five kingdoms of life.
Contact: Emily Holton
(415) 604-5471

**Ecosystem Science and Technology** — Interdisciplinary research in ecosystem science and technology looks at the role of life in modulating the complex cycling of materials and energy throughout the biosphere. Intact ecosystems, with particular emphasis on temperate and tropical forests, are examined by remote sensing from aircraft and spacecraft and by field site visits, with subsequent laboratory and computer analysis of the data gathered.
Contact: Jim Lawless
(415) 604-5900

**Search for Extraterrestrial Intelligence** — The Search for Extraterrestrial Intelligence has as its goal the detection of intelligent life elsewhere in the universe. The approach is to examine portions of the radio spectrum, using state-of-the-art search systems to detect and confirm signals of extraterrestrial intelligent origin. The present program is largely concerned with the design of the signal processing hardware and algorithms that will permit us to sift through thousands of megahertz of bandwidth in search of artifact signals that may be only a few hertz wide. The fields of digital signal processing, VLSI design microcoding, statistics, and astronomical aspects of the search are all germane to this effort.
Contact: Bernard Oliver
(415) 604-5166

**Neurosciences** — Research in neurosciences examines how the nervous system adapts to environmental conditions encountered in space, how adaptive processes can be facilitated, and how human productivity and reliability can be enhanced. To elucidate mechanisms underlying adaptation, neurosciences research includes neurochemistry, neuroanatomy, neurophysiology, vestibular physiology, psychophysiology, and experimental and physiological psychology. State-of-the-art facilities include human and animal centrifuges, linear motion devices, an animal care facility, a human bed-rest facility, and NASA's Vestibular Research Facility.
Contact: Mal Cohen
(415) 604-6441

**Space Physiology** — Multidisciplinary research in space physiology emphasizes the effects of microgravity on cardiovascular, musculoskeletal, and regulatory systems of humans and animals. Actual microgravity and ground-based models of simulated microgravity are used to investigate basic mechanisms of adaptation to space and readaptation to Earth. Physiological, biomechanical, cellular, and biochemical factors are also studied to develop appropriate countermeasures for maintaining health, well-being, and performance of humans in space.
Contact: Alan Hargens
(415) 604-5746

**Solar System Exploration** — Solar system exploration research defines flight experiments and related data bases and develops analytical concepts and prototype flight instrumentation for the extraterrestrial study of exobiology (history of the biogenic elements, chemical evolution, and origin and early evolution of life). Particular emphasis is placed on the biogenic elements (C, H, N, O, P, S) and their compounds as they relate to the composition and physical characteristics of the various bodies and materials of the solar system, such as cometary nuclei and comae and planetary atmospheres and surfaces. Experiment and instrument definition studies for Mars, Space Station *Freedom* microgravity facilities, interplanetary dust particles, and comet sample return are currently being conducted.
Contact: Glenn Carle
(415) 604-5765

**Planetary Biology** — Interdisciplinary research in planetary biology is aimed at understanding the factors in cosmic, solar system, and planetary development that have influenced the origin, distribution, and evolution of life in the universe and the course of interaction between biota and Earth's surface environments. Hypotheses are formulated and tested by two major approaches: (1) analysis of samples, such as cosmic dust, planetary materials, ancient and recent rocks and sediments, and extant microorganisms, and (2) use of simulation, ranging from laboratory experiments to computer modeling.
Contact: Sherwood Chang
(415) 604-5733

## Earth System Science

In Earth System Science, the focus at Ames is to perform and lead research within the disciplines of atmospheric and ecosystem science, with particular emphasis on how the biosphere and atmosphere interact to influence the evolution of the global system on all time scales.

**Earth Atmospheric Chemistry and Dynamics** — Research in this area includes the development of models and the use of airborne platforms and spacecraft to study chemical and transport processes that determine atmospheric composition, dynamics, and climate. These processes include the effects of natural and man-made perturbations.
Contact: Phil Russell
(415) 604-5404

**Atmospheric Physics** — Research in this area includes laboratory spectroscopy, airborne platforms, and spacecraft to advance the knowledge and understanding of the physical processes that determine the behavior of the atmosphere on the Earth and other solar system bodies.
Contact: Francisco Valero
(415) 604-5510

**Ecosystem Science** — Research in this area is directed to advanced understanding of the physical and chemical processes of biogeochemical cycling and ecosystem dynamics of terrestrial and aquatic ecosystems through the utilization of areospace technology.
Contact: Jim Lawless
(415) 604-5900

# *Hugh L. Dryden Flight Research Facility*

*Program Administrator:*
*Ms. Meredith Moore*
*Mail Stop 241-3*
*NASA Ames Research Center*
*Moffett Field, CA 94035*
*(415) 604-5624*

*The research program at the Dryden Flight Research Facility, Edwards Air Force Base, California, is administered by the Ames Research Center. The program includes most engineering disciplines in aeronautics, with emphasis on flight systems integration and flight dynamics. The following descriptions identify the current activities relevant to the Dryden program for which qualified students may apply.*

**Advanced Digital Flight Control —** Modeling, simulation, and flight test of distributed control systems. Design criteria and methods for unconventional vehicles, including decoupling of asymmetrical airplanes and stabilization of highly unstable airframes.
Contact: Joseph Gera
(805) 258-3795

**Flight Systems —** Engineering aspects of the formulation, design, development, fabrication, evaluation, and calibration of flight control, avionic, and instrumentation systems used onboard complex, highly integrated flight research vehicles. Work with fault tolerant redundant microprocessor-based control systems, microprocessor-based measurement systems, transducers, actuators, techniques for system safety, and hazard analysis.
Contact: Vince Chacon
(805) 258-3791

**Flight Dynamics —** Pilot/aircraft interaction with advanced control systems and displays, assessing and predicting aircraft controllability, developing flying qualities criteria, parameter estimation, and mathematical model structure determination.
Contact: Bruce Powers
(805) 258-3732

**Flight Test Measurement and Instrumentation —** Flow measurement, skin friction drag, fuel flow, integrated vehicle motion measurements, space positioning, airframe deflection, sensor and transducer miniaturization, and digital data processing.
Contact: Rodney Bogue
(805) 258-3193

**Fluid Mechanics and Physics —** Laminar and turbulent drag reduction configuration aerodynamics, experimental methods, wing/body aerodynamics, full-scale Reynolds number test technology, high angle of attack aerodynamics, applied mathematics, and atmospheric processes.
Contact: Robert Meyers
(805) 258-3707

**Propulsion/Performance —** Propulsion controls, integrated propulsion/airframe systems, and vehicle performance measurement.
Contact: Larry Myers
(805) 258-3698

**Structural Dynamics —** Aerostructural modeling, vibration and flutter analyses/predictions, aircraft flutter, flight envelope expansion, ground vibration and inertia testing, aeroservo/elasticity, active control of structural resonances, and advanced flight test technique development.
Contact: Mike Kehoe
(805) 258-3708

**Aircraft Automation —** Knowledge-based systems development, verification and validation of knowledge-based systems, neural networks, heuristic controllers, knowledge-based acquisition/implementation, maneuver controllers, performance optimization, guidance, pilot-vehicle interface, and robotic aircraft.
Contact: Lee Duke
(805) 258-3802

**Integrated Test Systems and Aircraft Simulation —** Development of Integrated System Test equipment, including aircraft/simulation interface equipment, automated test equipment, and applied artificial intelligence techniques for diagnosis and control. Flight simulation development for advanced aircraft systems in aerodynamic, propulsion, and flight control modeling.
Contact: Dale Mackall
(805) 258-3408

# *Goddard Space Flight Center*

*Program Administrator:*
*Dr. Gerald Soffen*
*Director, University Programs*
*NASA Goddard Space Flight Center*
*Code 160*
*Greenbelt, MD 20771*
*(301) 286-9690*

*The mission of Goddard Space Flight Center is to expand knowledge of the Earth and its environment, the solar system, and the universe through observations from space. To assure that our nation maintains leadership in this endeavor, we are committed to excellence in scientific investigation, in the development and operation of space systems, and in the advancement of essential technologies.*

*Graduate Student Researchers Program opportunities are available in the Space Sciences Directorate, the Earth Sciences Directorate, the Engineering Directorate, and the Mission Operations and Data Systems Directorate. Research opportunities at Goddard's two remote facilities—the Goddard Institute for Space Studies in New York City and the Wallops Flight Facility on Wallops Island, VA—are included in these listings. Qualified applicants are encouraged to explore areas of interest with the contacts listed here prior to submitting a proposal. All proposals should come to the program office in Greenbelt, MD.*

## Space Sciences Directorate

The Space Sciences Directorate plays a leading role in conceiving and developing instruments and spacecraft for the scientific exploration of space through its three research organizations:

— Laboratory for Astronomy and Solar Physics
— Laboratory for Extraterrestrial Physics
— Laboratory for High Energy Astrophysics

Also, through its Orbiting Satellites Project, the Directorate manages scientific spacecraft developed by Goddard.

Contact: Kenneth J. Frost
(301) 286-8824

**Laboratory for High Energy Astrophysics —** High energy astrophysics is the study of those physical processes, in an astronomical setting, that typically occur in plasma at temperatures above a few million degrees. Continuum X-ray and gamma ray emissions are produced by the interactions of charged particles with matter and electromagnetic fields, so that the study of such radiation is the study of these interactions in remote settings, while cosmic ray studies sample the charged particle distributions locally. Discrete lines in the X-ray and gamma ray spectra can be related to extreme environments in compact objects (ultra-high magnetic fields, for example), and can trace nucleosynthesis through nuclear or atomic transitions. In the Laboratory for High Energy Astrophysics, a broad program of experimental and theoretical research is conducted in all phases of astrophysics that deal with cosmic particles and the high energy quanta that their interactions produce. Experiments that measure cosmic X-rays, gamma rays, and charged particles are designed, built, and flown on balloons, rockets, Earth satellites, and deep space probes. The resulting data are analyzed and interpreted by laboratory scientists and their associates. In so studying the physics of solar, stellar, galactic, and metagalactic high energy processes, theoretical models of the origins and histories of these particles and quanta are developed.

Contact: N. White
(301) 286-8443
Archival X-ray and gamma ray data analysis

E. A. Boldt
(301) 286-5853
Cosmological X-ray studies

J. Swank
(301) 286-9167
Stellar X-ray sources

R. Mushotzky
(301) 286-7579
Extragalactic X-ray sources

C. E. Fichtel
(301) 286-6281
High Energy (>20MeV) gamma rays

T. L. Cline
(301) 286-8375
Low energy (0.02 - 20 MeV) gamma rays

J. F. Ormes
(301) 286-8801
Cosmic Rays

R. Ramaty
(301) 286-8715
Theoretical studies

**Laboratory for Astronomy and Solar Physics** — The Laboratory for Astronomy and Solar Physics conducts a broad program of research in observational and theoretical astronomy and solar physics. Observational programs, including technology and instrumentation development, span the spectral range from X-ray to radio wavelengths. Astrophysical phenomena of the Sun and stars are studied with emphasis on their structure, origin, and evolution. Investigations on the gross dynamics and transient properties of the atmospheres of the Sun and other stars are carried out, emphasizing phenomena revealed by spectroscopic observations made above the Earth's atmosphere and correlated with ground-based observations. The interstellar medium is studied, both on a large scale to elucidate the distribution of mass and luminosity in the galaxy and in individual clouds to probe processes of stellar formation, grain characteristics, and cloud chemistry. The Milky Way galaxy, other galaxies, quasars, and radio galaxies are studied, with special emphasis on those parameters bearing on the present structure of the universe, as well as on its origin, age, and future fate. The cosmic microwave and infrared background radiations are also studied to probe the early history of the universe. Additional research includes investigations of the chemical history of the solar system and the nature of the solar wind interaction with comets. Data of interest to laboratory scientists are currently being obtained from the International Ultraviolet Explorer (IUE), the Cosmic Background Explorer (COBE), and the Goddard High Resolution Spectrograph on the Hubble Space Telescope, archival data from these missions, the Solar Maximum Mission, the Infrared Astronomical Satellite (IRAS), and the Ultraviolet Imaging Telescope on the Astro Mission. The Space Telescope Imaging Spectrograph (STIS) will provide diffraction-limited spectral imagery when installed in the Hubble Space Telescope in the mid-1990s. The Solar and Heliospheric Observatory (SOHO) will provide new opportunities for study of the solar corona. Two missions, the Lyman Explorer and the Far Ultraviolet Spectroscopic Energy Solar Physics (HESP) mission, are being studied. Conceptual and technology studies for an Infrared Array Camera on the Space Infrared Telescope Facility (SIRTF) are in progress. Active suborbital observing programs are carried out from ground-based, airborne, balloon-borne, and rocket-borne instruments.

Contact: John Mather
(301) 286-8720
Infrared Astronomy

Susan Neff
(301) 286-5137
UV-Optical Astronomy

Richard Fischer
(301) 286-5682
Solar Physics

Michael Hauser
(301) 286-8701
Laboratory Chief

**Laboratory for Extraterrestrial Physics** — This laboratory performs research on the physical properties and dynamical processes active in solar, planetary, and stellar objects, and interplanetary and interstellar media. The chemistry and physics of comets, planetary atmospheres, magnetospheres, and condensed solar system matter, including meteorites, asteroids, and planets, are studied. A major effort is the analysis of data from Voyagers 1 and 2, the International Cometary Explorer spacecraft, the two Dynamics Explorer spacecraft, and the Combined Release and Radiation Effects Satellite. This research focuses on plasma studies, including magnetic fields, radio waves, and electron and ion plasmas that are located in planetary magnetospheres. Analysis also focuses on more recent Uranus and Neptune data, as well as heliospheric studies. Infrared spectra of the outer planets are also studied to deduce atmospheric properties. In infrared astronomy, the laboratory studies molecular astronomy, galactic infrared sources, as well as solar and planetary infrared astronomy. Instrumentation includes various diode laser heterodyne spectrometers and in-house developed instruments for use on the ground, in aircraft, and on balloons. Studies on molecules and chemical reactions of astrophysical and aeronomic interest are also conducted in the special facilities of the laboratories. Work is continuing on the scientific aspects of the International Solar Terrestrial Physics Program, the joint ESA-NASA Ulysses Solar Polar mission, and the first NASA Small Explorer mission (SAMPEX). Work is also under way on the Cassini mission to be launched to Saturn and on the Mars Observer spacecraft.

Contact: Daniel N. Baker
(301) 286-8112
Solar Terrestrial Studies

John J. Hillman
(301) 286-7974
Infrared Spectroscopy & Molecular Structures

Joseph A. Nuth
(301) 286-9467
Chemical Kinetics

L. Drake Deming
(301) 286-6519
Planetary Atmospheres

Steven A. Curtis
(301) 286-9188
Planetary Magnetospheres

James A. Slavin
(301) 286-5839
Electrodynamics

## Earth Sciences Directorate

The mission of the Earth Sciences Directorate is to provide leadership in achieving improved observations and understanding of global Earth systems processes and trends through the development and utilization of space technologies. The Earth systems being studied range from the deep interior (the core and the source of the magnetic field, the mantle, and its properties) through the surface (e.g., plate motion, soil formation, biospheric and hydrospheric processes, and ice studies), to the atmosphere (gaseous chemistry, trends, and, climate models), and beyond (the ionosphere, solar studies, and planetology). The Directorate keeps an aggressive basic and applied research program operating at a level that ensures strong vision and leadership while fulfilling its responsibilities encompassed by NASA and U.S. programs in Earth sciences.
Contact: Louis Walter
(301) 286-2538

**Laboratory for Atmospheres** — This laboratory performs a comprehensive theoretical and experimental research program dedicated to advancing our knowledge and understanding of the atmospheres of the Earth and other planets. The research program is aimed at advancing our understanding of the structure, dynamics, and radiative and chemical properties of the troposphere, stratosphere, mesosphere, and thermosphere, determining the role of natural and anthropogenic trace species on the ozone balance in the stratosphere, and advancing our understanding of the physical properties of the atmospheres and ionospheres of the Earth and other planets.
Contact: Franco Einavdi
(301) 286-5002

**Tropical Rainfall Measuring Mission (TRMM) Office** — The mission of this office is to develop a broad-based precipitation research and ground validation program, including a science data system for the Tropical Rainfall Measuring Mission (TRMM) that will meet both the pre-mission and the three-year mission flight phase science requirements.
Contact: Otto Thiele
(301) 286-9006

**Data Assimilation Office** — This office uses general circulation models and advanced statistical methods to produce global meteorological data sets which are physically and chemically consistent. Research not only involves all aspects of the assimilation system, but also applications of the data sets to problems of global variability and atmospheric chemistry and transport. Future research will involve oceanic and land surface models.
Contact: Richard Rood
(301) 286-8203

**Satellite Data Utilization Office** — Research in this office is oriented toward development of improved techniques to infer surface and atmospheric geophysical parameters from meteorological satellite observations for use in weather and climate studies. Major research areas are use of satellite data for initialization of general circulation models so as to improve numerical weather prediction skill and in production of multiyear climate data sets to study climate variability and trends. In addition, simulation studies are performed on future instruments to assess their potential impact on weather and climate studies.
Contact: Joel Susskind
(301) 286-7210

**Severe Storms Branch** — This branch performs research on a broad range of meteorological problems ranging from convective cloud scale through synoptic scale to the global scale. The research emphasis is on the initiation, evolution, and impact on atmospheric precipitating systems and on the remote measurement of precipitation. Scientists in the branch employ theoretical and numerical modeling methods, observational analyses, and participate in sensor development for the measurement of precipitation. Specific topics include tropical and mid-latitude convective precipitation systems, fronts and gravity waves, tropical and extratropical cyclones, air-surface interactions, and global precipitation analysis.
Contact: Robert Adler
(301) 286-9086

**Climate and Radiation Branch** — The primary function of the branch is to conduct basic and applied research with the goal to improve fundamental understanding of regional and global climate on a wide range of spatial and temporal scales. Research emphasis is on physical processes involving atmospheric radiation and dynamics, in particular, processes leading to the formation of clouds and precipitation and their effects on the water and energy cycles of the Earth. Branch scientists adopt a variety of approaches to meet this goal.
Contact: William K. M. Lau
(301) 286-7208

**Planetary Atmospheres Branch** — The Planetary Atmospheres Branch conducts theoretical and experimental research in the upper atmospheres and ionospheres of the Earth and other planets. Research in the atmospheres of the planets involves concentration

on the physics and chemistry of their mesospheres, thermospheres, exospheres and ionospheres, and coupling between these regimes.
Contact: Richard Hartle
(301) 286-8234

**Atmospheric Experiment Branch** — This branch conducts experimental research in terrestrial, cometary, and planetary atmospheres concerning chemical composition, atmospheric structure, and dynamics. Scientists and engineers in the branch participate in scientific investigations from experiment conception through flight hardware development, space flight, and data analysis and interpretation. Instruments developed for space flight are primarily for the purpose of *in situ* measurement of atmospheric parameters.
Contact: Hasso Niemann
(301) 286-8706

**Atmospheric Chemistry and Dynamics Branch** — This branch is involved in research aimed at understanding the radiation-chemistry-dynamics interaction in the troposphere-stratosphere-mesosphere system. Scientists in the branch employ global-scale modeling, satellite measurements, especially of ozone, and the collection, analysis, and interpretation of global-scale data to aid in this atmospheric understanding.
Contact: Mark Schoeberl
(301) 286-5819

**Environmental Sensors Branch** — Conceives of and develops advanced remote sensing techniques to measure chemical species and meteorological parameters of the Earth's atmosphere. Conducts satellites, balloon, aircraft, and ground-based studies and experiments leading to improved observational techniques. Performs supporting theoretical and laboratory studies, and develops defendable calibration methods and procedures. Develops appropriate data analysis algorithms to convert observable data into useful geophysical results. Coordinates with other elements of the laboratory in conducting joint studies which demonstrate the utility of future remote sensing systems to regional and/or global scale studies of the atmosphere. Concentrates on the development of new and novel lidar systems by advancing the state-of-the-art of the systems to meet the needs of the atmospheric chemistry and meteorological communities.
Contact: Harvey Melfi
(301) 286-7024

**Laboratory for Terrestrial Physics** — The Laboratory for Terrestrial Physics performs research directed at advancing the state of knowledge in the Earth sciences and the management of the resources of the Earth through the use of space technology. These efforts include solid Earth geophysics, geology, space geodesy and the study of the biosphere. Objectives are the complete, fruitful utilization of data of the Earth obtained from satellites and the development of future satellite systems that will enable deeper understanding of the Earth system. Activities include laboratory and field investigations, acquisition and use of data gathered aboard spacecraft and aircraft, and numerical simulation and modeling. Applicants should discuss potential research programs with the appropriate point of contact below.
Contact: D. Smith
(301) 286-8671

**Solid Earth Geophysics** — Research topics include the structure and composition of the Earth's interior through geodetic studies of the gravity and magnetic fields, the study of the lithosphere through magnetic anomalies, the rotational parameters of the Earth and planets, the measurement of topography with altimeters, and the study of planetary landforms.
Contact: B. Bills
(301) 286-8555

**Biospheric Studies** — These include research on the interactions of electromagnetic radiation with plant canopies that permits the remote measurement of biomass and vigor and the study of phenomena such as deforestation and acid rain.
Contact: D. Williams
(301) 286-8860

**Experimental Instrumentation** — Develops advanced electro-optic and laser sensors for ground-based, airborne and spaceborne Earth and planetary science applications. Work includes laser and detector research, sensor development research and conceptual design, performance calculations, sensor engineering, and fabrication, as well as instrument calibration and integration. Sensors are used for measurements of Earth and planetary surfaces and of the Earth's atmosphere and oceans. Develops and manages advanced laser sensors, including laser altimeters and lidar systems, for airborne and spaceborne use.
Contact: J. Abshire
(301) 286-2611

**Sensor Concepts and Calibration** — Studies and analyses are directed toward development of optical remote sensing systems for observing reflected solar and emitted thermal radiation from the Earth/atmosphere system. Research in advanced technologies enables new systems and research in techniques improves the precision of pre- and post-launch characterization/calibration. Research is directed at development of methods and methodologies to track the performance in orbit of sensors such as MODIS for EOS and the AVHRRs and NOAA. Unique tools for these studies include laboratory standards and a sensor which operates on the NASA ER-2 aircraft.
Contact: B. Guenther
(301) 286-5205

**Space Geodesy** — Research uses precise geodetic methods, including laser ranging and very long baseline interferometry, altimetry, and data from highly accurate tracking systems such as GPS and doppler, gradiometry and satellite-to-satellite tracking to measure and study the motion of the Earth on its axis, the kinematics of plate motion, the deformation of the crust, the Earth and ocean tides, and models of the gravity fields of the Earth and planets.
Contact: B. Putney
(301) 286-6018

**Laboratory for Hydrospheric Process** — The laboratory performs theoretical and experimental research on various components of the hydrological cycle and its role in the complete Earth system. The program is aimed at observing, understanding, and modeling the global oceans and ice, surface hydrology, and mesoscale atmospheric processes. The laboratory conducts research on Earth observational systems and techniques associated with remote and *in situ* sensing.
Contact: Antonio Busalacchi
(301) 286-6171

**Oceans and Ice Branch** — This branch conducts oceans and ice research to enhance understanding of these systems and their relationships with other elements of the biosphere and the geosphere. Works on problems in biological, physical, and polar oceangraphy, glaciology, and marginal ice zones and air-sea interactions. Pursues interdisciplinary studies on problems such as those involving the biomass, productivity, nutrient distributions, carbon fluxes, geostrophic and thermohaline circulation of tropical, mid-latitude, and polar oceans, and upwelling and ice sheets.
Contact: Chester Koblinsky
(301) 286-4718

**Observational Science Branch (Wallops Island, VA)** — This branch conducts theoretical and experimental research on observational systems and techniques for oceanic remote sensing. Develops and operates research facilities (i.e., wave tank, laboratory field standards, aircraft remote sensors), ground-based ozone, and wind sensors to obtain scientific data and develop new sensors.
Contact: Dave Clem
(804) 824-1515

**Hydrological Sciences Branch** — The Hydrological Sciences Branch conducts research activities which contribute to an improved understanding of the exchange of water between the Earth's surface and its atmosphere. These research activities emphasize the use of remote sensing over a wide range of electromagnetic frequencies as a means of studying various hydrological processes and states, such as precipitation, evapotranspiration, soil moisture, snow and ice cover, and fluxes of moisture and energy. In addition, advanced numerical and analytical models are developed.
Contact: E. Engman
(301) 286-5480

**Microwave Sensors Branch** — This branch performs research and development on advanced microwave sensing systems and data collection systems directed at providing remote and *in situ* data for research in the areas of the oceans, ecology, weather, climate, and hydrology. Performs basic theoretical, laboratory, and field studies that elucidate the interaction of electromagnetic radiation with the environment to improve our understanding of remote sensing systems. Branch members contribute to the development of microwave science and engineering for the Tropical Rainfall Measurement Mission (TRMM), the Earth Observing System (EOS), and various airborne campaigns.
Contact: James Weinmann
(301) 286-3175

**SeaWiFS Project** — The Sea-viewing Wide-Field-of-view Sensor (SeaWiFs), to be launched on Orbital Sciences Corporation's SeaStar satellite in August 1993, will provide global observations of ocean color for NASA. These data will be used to assess phytoplankton abundance, ocean productivity, and the ocean's role in the global carbon cycle. In addition, the observations will help visualize ocean dynamics and the relationships between ocean physics and large-scale patterns of productivity.
Contact: Wayne Esaias
(301) 286-5465

**Space Data and Computing Division** — The Space Data and Computing Division provides comprehensive research, development, and support in data handling and computing for space and Earth science research programs. The division manages and operates a NASA Supercomputing Center, a National Space Science Data Center, and a Global Change Data Center—all in support of space and Earth sciences. The increasing complexity, variety, and volume of data needed for research in Earth and space sciences require the development and integration of advanced computing tools and techniques.
Contact: Mike Hollis
(301) 286-7591

**Science Network Office** — This office conducts advanced research in the development of network control management systems, computer communications architecture, fiber optics, network computer simulation, and high-speed LAN and WAN network development.
Contact: J. P. Gary
(301) 286-9804

**NASA Center for Computational Sciences** — The center is engaged in the application of advanced computer system architectures, such as the CRAY Y-MP and the massive parallel processes, such as the MASPAR, to support complex computational physics modeling efforts. These modeling efforts involve, for example, studies of coupled multi-dimensional ocean and atmospheric systems, multi-dimensional magnetospheric-ionospheric systems, and astrophysical processes. Specific research opportunities exist for development of new numerical algorithms in computational physics that utilize advanced computer architectures, development of advanced scientific visualization, algorithms for visualization of space and Earth sciences processes, and the development of advanced techniques for managing decaterabyte mass data storage and delivery.

Contact: Daniel S. Spicer
(301) 286-7334

**National Space Science Data Center** — The center offers exceptional opportunities for computer scientists seeking to apply advanced data systems concepts to NASA's challenging space data problems. Areas of interest include on-line Data Base Management Systems, heterogeneous multisource data bases, transaction management, and data base logic. Research is conducted on advanced data systems for scientific data management using expert systems, data base machines, digital optical disk technology and computer visualization, and on developing interactive scientific data systems integrating data archiving, catalog, retrieval, data and image manipulation, and transmission techniques into distributed systems.

Contact: Jim Green
(301) 286-7354
On-line Data Systems

Joseph King
(301) 286-7355
Optical Disks

Greg Goucher
(301) 286-9884
Computer Visualization

Barry Jacobs
(301) 286-5661
Data Base Management

**Global Change Data Center** — The Global Change Data Center (GCDC) provides Earth science data operations and archive management to key Earth science flight missions. The center ensures that data within the archive are readily accessible through the Goddard Distributed Active Archive Center (DAAC) and operates key advanced data systems in support of NASA flight missions. The GCDC interacts closely with the scientific community being served. The Earth Observing System (EOS) Systems Development Office is responsible for supporting the EOSDIS Project Office for science and data systems support across all of the EOS DAACs. This includes the EOS DADS (Data Archive and Distribution System) and the EOS IMS (Information Management System). The Goddard DAAC Facility is responsible for the acquisition, archiving, and dissemination of scientific data from specific Earth science missions. It develops, implements, and operates the Goddard DAAC data system, interfaces the Goddard DAAC with the other NASA DAAC systems in order to provide timely access to archived data and information, provides special services for the Earth science communities, performs scientific analysis, and generates multi-disciplinary databases. The Earth Science Data Operations Facility works closely with flight project personnel in data system planning and utilization, and develops and implements the capability to support Earth sciences mission needs. The facility is responsible for supporting instrument algorithm development and operational project data set production systems, develops such systems for specific NASA flight projects such as the Earth Probes, and leads the development of nationally accessible advanced data products for the areas of Earth science. It conducts research in advanced computer science methodologies for application to science data operations.

Contact: Dorothy Zukor
(301) 286-8551
Global Change Data Center

Yun-Chi Lu
(301) 286-4093
EOS Systems Development Office

Roger Dilling
(301) 286-4067
Goddard DAAC Facility

Richard Kiang
(301) 286-2507
Earth Science Data Operations Facility

## Goddard Institute for Space Studies (New York, NY)

— The Institute for Space Studies conducts comprehensive theoretical and experimental research programs in four major areas.

**Causes of Long-Term Climate Change** — Basic research on the nature of climate change and climatic processes, including the development of numerical climate models. Primary emphasis is on decadal or end-of-century global-scale simulations, including studies of humanity's potential impact on the climate. Climate sensitivity and mechanisms of climatic change are investigated in global paleoclimatic research, specifically from the comparison of pollen and glacial data with paleoclimatic model simulations. In addition to their use for climate simulations, the global models are used to simulate the transport of atmospheric constituents and thus study their global geochemical cycles.

The program also includes development of techniques to infer global cloud, aerosol, and surface properties from satellite-radiance measurements as part of the International Satellite Cloud Climatology Project and the Earth Observing System and analysis of the role of clouds in climate.

Contact: Anthony Del Genio
(212) 678-5588
Convection and Clouds

James Hansen
(212) 678-5619
Greenhouse Effect

Dorothy Peteet
(212) 678-5593
Paleoclimate, Pollen Studies

David Rind
(212) 578-5593
Climate Dynamics, Stratosphere

William Rossow
(212) 678-5567
Global Cloud Properties

Andrew Lacis
(212) 678-5595
Radiative Processes

**Planetary Atmospheres** — Concerned with investigations of Jupiter, Saturn, Venus, and the Earth. The observational phase of the program includes imaging and polarization measurements from the Pioneer Venus Orbiter and radiation-budget, temperature-sounding, photometric, and polarization measurements from the Galileo Jupiter Orbiter. The theoretical phase of the program includes interpretation of radiation measurements of planets to deduce bulk atmospheric composition and the nature and distribution of clouds and aerosols, and analytical models. Emphasis in the theoretical program is on analysis of physical processes in terms of general principles and models applicable to all planets.

Contact: Michael Allison
(212) 678-5554
Atmospheric Dynamics

Anthony Del Genio
(212) 678-5538
Atmospheric Dynamics

Barbara Carlson
(212) 678-5538
Radiative Transfer

**Biogeochemical Cycles** — Research on global biogeochemical cycles involving the study of chemically and radioactively important trace gases. The aim is to improve our understanding of the cycles of $CO_2$, $CH_4$, $N_2O$, CFCs, $O_3$, NOX, OH, and other trace compounds which are expected to affect climate and air quality in the near future. The research involves three-dimensional chemical tracer models, which are essential for determining the sources and sinks of these gases and for predicting future atmospheric composition. Central to the program is the investigation of the role of the biosphere, terrestrial and oceanic, in the global carbon cycle using a combination of satellite measurements and modeling.

Contact: Inez Fung
(212) 678-5590
Carbon Cycle, Ocean Modeling

**Interdisciplinary Research** — Interdisciplinary research ranges from theoretical studies of the origin of the solar system to relationships between the Sun, terrestrial climate, geological processes, and biology. One phase of the program involves the structure and evolution of accretion disks, especially the primitive solar nebula, using models of large-scale turbulence. Another topic is the calculation of molecular properties of atmospheric and astrophysical interest. A third area concerns the evolution and pulsation of bright stars, which may be analogs of the Sun. A biological question of special interest concerns how terrestrial vegetation will change during the next 50 years, when the climate and atmospheric $CO_2$ are expected to be changing.

Contact: Vittorio Canuto
(212) 678-5571
Large-Scale Turbulence

Sheldon Green
(212) 678-5562
Molecular Calculations

Richard Stothers
(212) 678-5605
Stars, Climate Studies

Dorothy Peteet
(212) 678-5587
Biology

## Engineering Directorate

The Engineering Directorate supports NASA space and Earth sciences and application programs through technical research and development. The directorate's enabling technology program increases knowledge and capabilities in areas necessary for the success of assigned NASA missions. The design, development, and test of components, subsystems, instruments and spacecraft for multiple programs and projects are important parts of the mission of the Engineering Directorate. The Engineering Directorate oversees the in-house development of flight hardware and software, including instruments, attached Shuttle Payloads, and small Explorer Spacecraft, and provides system and discipline engineering support for space and Earth science missions such as the Hubble Space Telescope and Earth Observing System.

Contact: George Alcorn
(301) 286-2463

**Robotics Branch** — Provides research and advanced development of telerobotic and autonomous robotics. Implements and provides an engineering test bed robotic system for the evaluation of robotic systems.

Responsible for advanced applied research in robotic elements and components. This includes robotic end effectors, grippers, special tools and mechanisms, sensors, and motors and other actuators. Performs system physical parameter determination and the dynamical and kinematical modeling and simulation of robotic systems. Provides advanced applied research in high level control and systems operation in the areas of robotic autonomy, mission and task planning, path decomposition, and coordinated control. Performs research in the integration of vision and other advance technologies into robotic systems. Provides guidance on the evolution of the robotic systems.

Contact: Stanford Ollendorf
(301) 286-3292

**Thermal Development Laboratory** — This laboratory is responsible for the development of new thermal control technology for future NASA spacecraft. Current work efforts focus on such technologies as cryogenic heat pipes, two-phase capillary pumped loops, and heat pumps. The scope of the work encompasses concept development, breadboard to prototype testing, conduction of flight experiments, and analysis. The 7,000 square foot laboratory/office area has numerous test loops. These range in size from small benchtop units to an 8x30-foot facility, which is the largest known modular two-phase test bed. A wide variety of instrumentation, data collection/processing, and other support equipment are available to support these testing efforts.

Contact: T. D. Swanson
(301) 286-6952

**Optics Laboratory** — The Optics Branch conducts research and development programs in the optical sciences and engineering to support flight experiment development in the areas of high energy astrophysics, solar and stellar astronomy, atmospheric sciences, and ocean and terrestrial sciences. Specific research and development objectives include optical property characterization of solids and thin films, diffraction grating technology, optical system design and analysis, and advanced optical fabrication and testing. Modern laboratory facilities are equipped for optical property studies in the far-infrared to the extreme ultraviolet generation of holographic diffraction gratings, and optical fabrication and testing. In addition, extensive computer facilities are available to support optical design and analysis studies.

Contact: John Osantowski
(301) 286-3873

**Electromechanical Branch** — Conceives, designs, develops, directs, tests, and provides those mechanical, optomechanical, and electromechanical systems required to support flight instrument and spacecraft projects. Conceives and conducts advanced research and development efforts to support new technology, such as cryogenic mechanisms, applicable to existing and future spaceflight requirements. Deployable appendages such as magnetometer booms and 100-meter electric field antennas are developed. Flight structures ranging in size from small optical benches to instruments weighing several tons are provided. Electromechanical systems and their control electronics are developed, taking into account the effect of spacecraft structural disturbances (jitter) where applicable. Modern laboratory facilities are equipped for electromechanical fabrication and testing.

Contact: John Sudey
(301) 286-8908

Willie Blanco
(301) 286-3964

**Cryogenics Laboratory** — This laboratory conducts research and development programs in low temperature physics in support of astrophysics goals. General research objectives are the development of low temperature microcalorimeters for the detection and imaging of charged particles and radiation, and high-precision and high-accuracy thermometry. Current research focuses on detectors and sensors using thin-film superconductors. This includes the development of detectors using tunnel junctions to obtain energy and/or spatial resolution, kinetic inductance calorimeters, and thermometry using superconductors. Modern laboratory facilities are equipped for detector characterization, including cryogenic workstations with automated data collection, SQUID systems, dilution and adiabatic demagnetization refrigerators, and facilities for evaporation and sputtering of thin films.

Contact: Stephen Castles
(301) 286-5405

**Photonics Branch** — The Photonics Branch conducts a broad program of theoretical research in electro-optics and quantum optics, including high power semiconductor lasers, high energy diode-pumped solid-state lasers, and tunable solid-state lasers used for Earth remote sensing applications and planetary *in situ* sensing. Currently, a major thrust exists in ultra fast laser technology applied to precise laser ranging for Earth geophysics research. Electro-optics technologies are being developed in support of intersatellite laser communications systems. Technologies under development include ultra low noise detectors, novel heterodyne receivers, and fiber laser preamplifiers. Instrumentation is being developed to support observational research in infrared astrophysics and solar physics. Technologies under development include acousto-optics tunable filters, large-format infrared detector arrays, infrared fiber optics, and cryogenic eschelle spectrometers. Near IR laser systems are being investigated

for planetary topside sounders and *in situ* laser LIDAR sensing.

Contact: Bernard D. Seery
(301) 286-8942
Photonics Branch

Michael Kraninak
(301) 286-2646
Optoelectronics Section

## Mission Operations and Data Systems Directorate

The Mission Operations and Data Systems Directorate is responsible for the following: (1) planning, design, development, and operation of space flight tracking and communications networks and data systems support of near-Earth space flight missions; (2) activities in mission planning, mission analysis, space and ground network operations, spacecraft and payload command and control, flight dynamics, information processing, and flight mission operations; (3) planning and applied research development of advanced data systems and telecommunications systems in support of space flight missions; and (4) ensuring that space and ground communications network, mission analysis and support computing capabilities, and end-to-end data systems meet mission support requirements and are maintained at the state-of-the-art.

Contact: Donald Wilson
(301) 286-7550
New Technology and
Data Standards Manager

**Data Systems Technology Division** — The Data Systems Technology Division develops and applies systems, hardware, and software technologies to support complex command and control, communications, and telemetry data processing requirements of future space missions. The division performs advanced technology development in high performance VLSI systems for telemetry processing, high data rate/ volume data storage architectures, distributed systems and networks, computer-aided software engineering, human-machine interface technology, and artificial intelligence—primarily in the areas of cooperating knowledge-based systems planning and scheduling, and monitoring and control. Joint projects are formed with other Goddard organizations to transfer technology from the laboratory into operational systems through the development of test beds and advanced operational prototypes. Application projects include VLSI-based telemetry front end processors and workstations, a test bed for distributed mission planning and scheduling, a computer-aided systems engineering support environment, an advanced user interface design and development environment (TAE Plus), an intelligent spacecraft control center test bed, and a prototype self-organizing network for distributed telemetry systems. Division laboratory facilities provide some of the most advanced systems design and development capabilities available, including a complete suite of VLSI design tools, libraries, and workstations, advanced commercial parallel disk farms; VME components for system integration; workstations from SUN, HP, DEC, IBM, Silicon Graphics, and NEXT; advanced tools for systems and software engineering, modeling, and human-computer interface design; and expert systems shells and development environments.

Contact: James Chesney
(301) 286-9029
VLSI Systems

Sylvia Sheppard
(301) 286-5049
Human-Machine Interfaces
Computer Aided Systems Engineering

Jay Costenbader
(301) 286-5292
Planning and Scheduling

Walt Truszkowski
(301) 286-8821
Artificial Intelligence

**Flight Dynamics Division** — Research is conducted toward the development of algorithms and techniques to support flight dynamics mission requirements. Areas of particular interest are spacecraft orbit and attitude dynamics modeling,the development of dynamics simulators, planning of launch and maneuver parameters to tailor spacecraft trajectories for specific missions, analysis and evaluation of advanced sensor and actuator hardware, including the characterization of error sources, and development of efficient and robust algorithms for the estimation of spacecraft attitude and orbit parameters. This research depends on contributions from astrodynamics, linear and nonlinear estimation theory, system identification, linear and nonlinear dynamic system analysis, and applied mathematics.

Major experiments are currently active or planned in the following disciplines:

- Ada, as a development language and overall design discipline
- Reusable software concepts and approaches
- Structured methodologies such as the "Clean Room" approach
- Software development environments
- Software maintenance tools and techniques

Research in the systems engineering disciplines includes:

- Development of advanced graphics techniques for flight dynamics problems
- Application of expert system technology to flight dynamics.

Contact: Frank McGarry
(301) 286-6846

# *Jet Propulsion Laboratory*

*Program Administrators:*
*Dr. Harry I. Ashkenas*
*Mail Stop 183-900*
*Jet Propulsion Laboratory*
*4800 Oak Grove Drive*
*Pasadena, CA 91109*
*(818) 354-8251*

*Ms. Carol S. Hix*
*University Affairs Office*
*Mail Stop 183-900*
*Jet Propulsion Laboratory*
*4800 Oak Grove Drive*
*Pasadena, CA 91109*
*(818) 354-3274*

***The primary role of the Jet Propulsion Laboratory within the NASA family is the exploration of the solar system, including planet Earth, by means of unmanned, autonomous spacecraft and instruments.***

***In addition, an active community of JPL scientists, technologists, and engineers is engaged in Earth atmosphere and geosciences, oceanography, planetary (including asteroid and comet) studies, and solar, interplanetary, interstellar, and astrophysical disciplines. Opportunities for Graduate Student Researchers exist in all technical divisions of JPL. These technical divisions, organized by general discipline area, encompass almost all JPL engineering and science resources. Each technical division is concerned with the planning, design, development, engineering, and implementation functions relevant to its discipline area. Fundamental to the structure of JPL is the cooperation among the research, science and advanced technology and the engineering functions of these operating divisions.***

## Systems Division

The Systems Division performs systems engineering and design integration for all the major projects undertaken by JPL. It also conducts specialized analyses in many disciplines to support these projects.
Contact: Christopher Carl
(818) 354-3017

**Mission Design —** Includes interplanetary spacecraft trajectory design, planning mission sequences to accommodate science requirements, launch vehicle trajectory analysis, studies of advanced interplanetary scientific missions, and software development to support mission design and analysis.

**Spacecraft System Engineering —** Supports JPL flight projects by providing design integration of the total spacecraft system, including its interfaces with the launch vehicle and with its scientific instrument payload. It also conducts studies and analyses of advanced future spacecraft designs and analyzes the performance of spacecraft in flight.

**Navigation Systems —** Develops the capability to determine very precisely the position and velocity of scientific spacecraft in interplanetary space through radiometric and optical techniques, designs propulsive maneuvers to place spacecraft on correct trajectories, develops complex software to solve the equations of motion, and conducts scientific studies of relativistic gravity, planetary orbital dynamics gravitational radiation and planetary mass and gravity fields using spacecraft radio tracking data.

**Mission Profile and Sequencing —** Develops the detailed sequences to be executed by interplanetary spacecraft, plans the commands required to carry out the sequences, and develops the software that keeps track of the command sequences and ensures the commands will safely perform the desired functions.

**Mission Information Systems Engineering —** Supports JPL flight projects in the development of plans for the operation of interplanetary spacecraft in flight. This involves design of the end-to-end data system from the spacecraft instrument to the scientist receiving the data, as well as design of ground-based systems of hardware, software, and teams used to process the data.

**Systems Analysis —** Performs economics, operations research, costing, and mission analyses for a broad spectrum of unmanned and manned space projects and military and civilian ground-based programs.

**Defense and Civil Information** — Performs system level design, integration, and development of information systems, including computer hardware and software and large distributed near real time ground data processing. Disciplines include traditional electrical, mechanical, aeronautical, and aerospace engineering, along with computer science, operations research, economics, and the physical sciences.

## Earth and Space Sciences Division

The division conducts a wide-ranging program of research in oceanography, the atmospheres and solid bodies of Earth and other planets, planetary satellites, asteroids, comets, interplanetary medium, search for extraterrestrial intelligence (SETI), and selected solar, stellar, and interstellar phenomena. Ground-based observations, aircraft, balloons, and Earth-orbiting and planetary spacecraft are utilized. Extensive laboratory and theoretical research efforts, data analysis, interpretation, and modeling support these observational programs.
Contact: Clifford Heindl
(818) 354-4603

**Oceanography** — Altimetry for determining currents and tides; air-sea interactions including, fluxes of mass, momentum, energy, and chemicals between ocean and atmosphere; determination of marine biomass and ocean productivity; sea ice dynamics and influence on climate variability; global surface temperature measurements; surface driving forces and wave propagation derived from radar observations.
Contact: Donald Collins
(818) 354-3473

**Earth Atmosphere** — Laboratory research, field measurements, and data analysis to understand the chemistry of stratospheric ozone; monitoring of long-term trends in important minor and trace constituents; extraction of meteorological parameters from satellite data, including temperature profiles, humidity, clouds, winds, and pressure.
Contact: James Margitan
(818) 354-2170

**Planetary Atmospheres** — Observations from ground-based telescopes and analysis of spacecraft data to determine composition, structure, and dynamics; long-term study of seasonal and interannual variability; global mapping; synthesis of information to determine physical processes and state of the atmospheres.
Contact: John Appleby
(818) 354-3943

**Earth Geoscience** — Characterization of exposed rocks, sediments, and soils on the Earth's surface to understand the evolution of the continents; examine state and dynamics of biological land cover for assessment of the role of biota in global processes; tectonic plate motion; volcanology; paleoclimatology.
Contact: Diane Evans
(818) 354-2418

**Planetology** — Observations of the surface of the inner planets, satellites and rings of the outer planets, asteroids and comets across the spectral range from ultraviolet through active and passive microwave; studies of meteorites and cosmic dust; theory and modeling relevant to the origin and evolution of the solid bodies of the solar system; development of approaches to the detection and characterization of solar systems around other stars.
Contact: Jeffrey Plescia
(818) 354-6936

**Space Physics** — Mapping of the magnetic fields of the Sun and planets and their time variations; structure and dynamics of the solar wind; and interactions of solar fields and particles with the magnetic fields and outer atmospheres of Earth and planets.
Contact: Marcia Neugebauer
(818) 354-2005

**Astrophysics** — Variability of the solar constant; sky survey of infrared sources; composition and chemistry of interstellar clouds; identification of gamma-ray sources within the galaxy and beyond; observations of supernova 1987A; studies of gravitational wave detection utilizing spacecraft.
Contact: Samuel Gulkis
(818) 354-5708

## Telecommunications Science and Engineering Division

**Astrophysics** — Observational and theoretical research into the nature of radio emissions from quasars, galaxies, and stars.
Contact: Robert Preston
(818) 354-6895

## Radio Science

**Gravitational Wave Studies** — Algorithm development and data analysis of spacecraft tracking data for the detection of very low-frequency gravitational waves predicted by general relativity and other theories of gravity.
Contact: John Armstrong
(818) 354-3151

**Planetary Atmospheres and Interplanetary Media** — Experimental and theoretical research investigations based on the use of spacecraft radio signals to probe planetary atmospheres and the interplanetary/solar plasma.
Contact: Richard Woo
(818) 354-3945

**Planetary Dynamics** — Determination of orbital, rotational, or atmospheric motions of planets by tracking of spacecraft or balloons associated with the planets.
Contact: Robert Preston
(818) 354-6895

**Asteroid Dynamics** — Study orbital evolution of main belt and planet crossing asteroids, resonances, and asteroid families.
Contact: James Williams
(818) 354-6466

**Geodynamics** — Experimental and theoretical investigations of global and regional phenomena using the modern space geodetic techniques of lunar laser ranging, Very Long Baseline Interferometry (VLBI) and the Global Positioning System (GPS).
Contact: Jean Dickey
(818) 354-3235

**Information Theory and Coding** — Theoretical research into information theory, channel and source codings with special emphasis on very noisy channels and some interest in fading and band-limited channels.
Contact: Laif Swanson
(818) 354-2757

**Optical Communication** — Theoretical and experimental research involving free space laser communications systems, components, and techniques, and including such items as lasers, detectors, modulators, signal design, large telescope design, spatial and temporal acquisition and tracking, detection strategies, and channel coding.
Contact: James Lesh
(818) 354-2766

**Frequency Standards Research** — Experimental investigations including ultra-high resolution spectroscopy to support development of stable sources of microwave and optical frequencies.
Contact: Lute Maleki
(818) 354-3688

**Planetary Radar Astronomy** — Experimental and theoretical research in planetary surface, atmospheres, and rings (including geology, spin dynamics, and scattering properties of rings and cometary debris swarms) using the ground-based Goldstone radar system to form images of terrestrial planets, asteroids, and comets.
Contact: Martin Slade
(818) 354-2765

**Radar Remote Sensing of the Earth** — Experimental and theoretical investigations in remote observation of the Earth's surface through radar scattering properties, for example, polarization and interferometry to determine the structure and motion of regions of interest.
Contact: Howard Zebker
(818) 354-8780

## Electronics and Control Division

**Control Systems** — Development of electronics, actuators and sensors to enable precision control of space systems. Development of modeling and simulation tools, computational procedures and architectures for design and analysis of electro-mechanical control systems.
Contact: Guy K. Man
(818) 354-7142

**Autonomous Control and Tracking Systems** — System architectures, sensors, and actuators for autonomous rendezvous, docking, aerobraking, and landing. Development of concepts to enable high bandwidth control of flexible space structures and to provide active space control. Advanced control systems and algorithm development for target tracking.
Contact: George Sevaston
(818) 354-0395

**Electro-optical Tracking Systems** — Development and testing of electro-optical sensors and algorithms for star, limb, and target-feature tracking. Development of interferometric metrology sensors and systems.
Contact: Randy Bartman
(818) 354-5320

**Power Research and Engineering** — Development of lightweight, high-power density photovoltaic arrays; high efficiency thermal-to-electric conversion for space nuclear power; high energy batteries; power electronics and automated power systems management.
Contact: Perry Bankston
(818) 354-6793

**Flight Computers** — Development of computer technology for flight application, including fault-tolerant architectures, special purpose VLSI, radiation resistance, high speed optical computing and networking.
Contact: John Davidson
(818) 354-7508

**Microelectronic Device Research** — A wide variety of research is being pursued using the new Microdevices Laboratory: submillimeter and infrared radiation detectors, electron tunneling microscopy, quantum will structures, molecular beam epitaxy, chemical vapor deposition, E-beam lithography, transmission electron microscopy, etc.
Contact: Barbara Wilson
(818) 354-2969

**Autonomous Mobile Vehicle** — Real-time path planning in uncertain terrains; wheeled locomotion and mobility, image processing for rover control, and combined mobility and manipulation.
Contact: Brian Wilcox
(818) 354-4625

**Robot Arm Control** — Research in advanced modeling, adaptive control,

hierarchical control software architectures, complex task simulation, etc., as they pertain to redundant dual-arm manipulation systems.
Contact: Homayoun Seraji
(818) 354-4839

**Advanced Teleoperation and Man-Machine Systems —** Man-machine interfaces for advanced teleoperation and supervisory automation, including the development of electro-mechanical, graphics, and computing architectures. Also, human-factors-based experiments and data analysis.
Contact: Paul Schenker
(818) 354-2681

**Data Storage Technology —** Investigation of semiconductor and magnetic materials for the development of data storage technology for space, including advanced technology such as Vertical Bloch Lines (VBL).
Contact: Henry Stadler
(818) 354-3556

## Mechanical and Chemical Systems Division

The Mechanical and Chemical Systems Division carries out research in a number of areas related to structures, materials, and thermal sciences. Research opportunities exist in the development of dimensionally stable composite materials, polymeric materials with unique electronic and optical properties, use of active members to control vibrations and for shape control of precision structures, cryogenic cooling systems, including sorption refrigeration, adaptation of Stirling cycle coolers to space instruments, and advanced superfluid helium cryostats, electric propulsion and autonomous mobility, and sample acquisition.
Contact: Donald Rapp
(818) 354-4931

## Information Systems Division

The Information Systems Division performs research and development activities concerned primarily with ground-based information systems dealing with spacecraft data acquisition, radio science, monitor and control, and telemetry. Research areas include: (1) expert systems in spacecraft diagnosis and ground system automation; (2) graphics and simulation for knowledge fusion, data understanding, and training; (3) high-rate, high-capacity information networks; (4) software productivity and reliability; (5) distribution, archival, and intelligent access to large, interactive NASA databases; and (6) high-performance computing.
Contact: Robert C. Tausworthe
(818) 306-6284

## Institutional Computing and Mission Operations Division

This division is responsible for research, development, planning, and operations necessary for: (a) spacecraft assembly, test, integration to launch vehicle, launch operations, and ground system integration and test; (b) mission control, command, data management, and non-imaging science data handling, product generation, and quick-look processing; (c) institutional computing, communication, and computer network services, including the CRAY; (d) institutional and microprocessor software applications; and (e) electronic, electrical, optical, and physical measurements, and measurement standards.
Contact: Kristine Blom
(818) 354-0119

## Observational Systems Division

The Observational Systems Division is responsible for the conception, design, engineering development, and implementation of a variety of scientific instrumentation for space flight applications. A key element in the division is digital image processing research and development for space science and environmental and Earth resources applications.
Contact: Kane Casani
(818) 354-4040

**Imaging Systems —** Design, development, and implementation of imaging and spectrographic systems for use in space science investigations. Developed imaging systems for Voyager, Galileo, and Hubble Space Telescope missions. Recently delivered the Pressure Modulator Infrared Radiometer instrument for the Mars Observer Mission. Currently developing imaging systems for the Cassini Mission, the Multiangle Imaging Spectroradiometer for the Earth Observing Mission, and the Pressure Modulator Infrared Radiometer instrument for the Mars Observer Mission. In addition to end-to-end engineering of flight instruments, the section is at the forefront in research and advanced development for solid state imaging array detectors for X-ray, ultraviolet, visible, and shortwave infrared detection. These advanced scientific imaging detectors will support development of the next generation of spaceborne imaging systems.
Contact: Christopher Stevens
(818) 354-5545

**Infrared and Analytical Instrument Systems —** Conception, design, advanced development, and implementation of scientific instrumentation for remote sensing in the infrared and *in situ* analyses of chemical species using mass spectrometry and scanning electron

microscopy. Missions addressed include planetary exploration, Earth remote sensing, and astrophysics. This section is particularly active in the development of imaging spectrometry for a wide variety of applications. This is a measurement technique in which materials may be identified through their unique spectral signatures. The section is also active in the development of enabling technology, particularly IR Focal Plane Arrays and related components.
Contact: Mark Herring
(818) 354-6817

**Microwave Observational Systems** — Conceive, design, implement, and calibrate scientific radiometer systems in the microwave through submillimeter wavelength regions. This includes advanced research and technology development of submillimeter wave components and advanced spectrometers to support near term and future remote sensing missions. They develop opportunities for new microwave instrument systems with the user community. They also develop theoretical models describing the interaction between microwave signals and the atmospheric and surface parameters.
Contact: Tom Fraschetti
(818) 354-6677

**Image Processing Applications and Development** — Develops and applies image processing techniques to the display, analysis, and interpretation of image and image-related data. Utilizing engineering and artificial intelligence to develop automated and semi-automated schemes for data interpretation. Performs research and development in image processing. Also develops and applies specialized software, hardware, and systems architectures to increase the speed of computationally intensive functions on large data sets. Provides image processing and analysis support to the flight projects, imaging teams, and the science community.
Contact: Ray Wall
(818) 354-5016

**Optical Sciences and Applications** — Basic and applied research in advanced optics technologies. Uses unique computational tools for optical design and system analysis to support development of various remote sensing systems for astrophysics and Earth and interplanetary scientific measurements. Large mirror advanced optical materials, adaptive optics, thermal infrared optics, ultra-low scattered light optics, electro-optics, hyperspeed image correlators, and sensor systems for the Long-Baseline Michelson Stellar Interferometer are examples of study areas. Development of advanced space flight hardware optical systems for use in the visible, infrared, ultraviolet, and submillimeter spectral regions for science applications take place in this section.
Contact: James Breckinridge
(818) 354-6785

**Earth Observations Analysis Systems** — Design, develop, validate, and operate data systems for Earth and astrophysical observing systems. Provide algorithms and models both of the instruments and the observed phenomena necessary to extract meaningful geophysical and astrophysical information from these observations. Use state-of-the-art parallel computational systems to implement these algorithms. Areas of active work include plasma physics, atmospheric modeling, modeling of electromagnetic scattering of microwaves, and radiative transfer in the atmosphere. Field experiments are also performed.
Contact: Jack Fanselow
(818) 354-6323

## Hardware Assurance Division

This division carries out research into the reliability of electronic parts and components in the harsh radiation environments experienced by spacecraft. Current activities include investigations into the effects associated with cosmic ray and heavy ion-induced upsets and damage in electronic components, laser simulation of single event upsets in electronic devices, evaluation of test methodologies and process technologies used to produce reliable Application Specific Circuits (ASIC) and long lived (>10 years) electronic components, and in the area of radiation effects on RF devices and optical devices such as Charged Couple Devices (CCDs).
Contact: A. E. Cherniack
(818) 354-4167

## Systems Assurance Division

This division conducts research in a wide range of areas concerned with the quality and reliability of spacecraft systems. Research opportunities exist in the modeling, analysis, and simulation of the natural and induced spacecraft mission environments and of their effects on spacecraft systems, subsystems, and individual components. Software reliability analyses and metrics definition are other areas of rapidly growing research. Specific issues associated with software, spacecraft sensors, control systems, and other flight hardware are of interest.
Contact: A. G. Brejcha
(818) 354-3080

**Reliability Engineering** — Develops reliability and environmental design, analysis, and test requirements for all JPL flight projects. Reliability activities include electrical and mechanical analyses and environmental requirements activities include: thermal, dynamics, electromagnetic

compatibility, and natural space environments. Natural environments include solar and planetary thermal conditions, micrometeoroids and space debris, and space plasma. Induced environments include vibration, acoustic, pyrotechnic shock, and thermal loads, electromagnetic effects, spacecraft charging, etc.
Contact: T. E. Gindorf
(818) 354-4451

**Software Product Assurance** — Software Product Assurance has the objective to help ensure the operational integrity of the software developed for JPL systems, and evaluates the operational requirements, the acceptability and readiness of all software prior to delivery. It also researches advanced techniques in software engineering, human-computer interface, software safety, and metrics, and performs technology transfer to techniques tailored for the JPL and NASA environment to improve the quality of software within JPL and NASA.
Contact: R. Santiago
(818) 354-2452

## Flight Projects Support Office

The Flight Projects Support Office integrates the development of hardware and software tools to provide efficient and effective multimission operations systems and services to JPL's planetary science projects in order to minimize the cost of mission operations and data analysis. These systems and services include spacecraft analysis and navigation, mission planning and sequencing, science analysis, mission control and data management, computers and communications, and telemetry.
Contact: Steve Huffman
(818) 354-6068

**Chief Engineer** — Provides top-level problem identification, isolation, and correction activity. Activities currently include data system security, space flight operations facility security, and data systems standards.
Contact: Bob Polansky
(818) 354-4940

**Program Control and Administration (PC&A)** — Integrates the resources planning, scheduling, statusing, and reporting functions to provide costs and schedule control tools for management. Office utilization and automation, personnel administration, network administration, and inventory control are also integral parts of the PC&A function. Client/server architecture and LAN technology serves as the backbone for communications between the PC&A functions and all levels of management. New challenges lie in the development of a cost model for estimating mission operations and data analysis costs for new missions.
Contact: Kirk Gerbracht
(818) 354-3107

**Advanced Systems** — Focuses on the development and utilization of advanced technology for mission operations and data analysis with the primary goal of increased productivity at lower cost.
Contact: Jim Blue
(818) 354-2054

**Flight Projects Interface** — Provides the focus for interactions between the Flight Projects Support Office and various flight projects, assuring proper understanding and documentation of flight project requirements and the Flight Support Office commitments to the projects.
Contact: Al Beers
(818) 354-3416

**Process Engineering** — Applies process improvement technology to multimission ground data systems development and operations, including metrics collection and analysis, and maintains configuration controls on a multiplatform, distributed network. Infrastructure developments include an integrated, on-line project management database, a knowledge-based system to automatically configure and restore network workstations from distributed configuration libraries, and configuration management tools.
Contact: Shirley Jeane
(818) 354-7086

**System Integration and Test Quality Assurance** — Plan, proceduralize, and execute system level tests to prove/disprove system compliance with defined functional, performance, and operability requirements. Administer quality assurance over test design and testing. Establish metrics to provide a quality measure of the development process and the product's capabilities.
Contact: Andy Dowen
(818) 354-8191

**Flight Support Facilities** — Maintains critical Space Flight Operations Facility resources such as emergency power, communications capabilities, and Deep Space Network interface. Controls the facility configuration during critical mission phases such as launch and encounter. Evaluates space requirements for flight project's Mission Support areas and plans facility modifications as required.
Contact: Jim Allen
(818) 393-7880

# *Lyndon B. Johnson Space Center*

*Program Administrator:*
*Dr. Stanley H. Goldstein*
*Director, University Programs*
*Mail Code AHU*
*NASA Lyndon B. Johnson Space Center*
*Houston, TX 77058*
*(713) 483-4724*

***The Johnson Space Center is involved in a wide range of activities dealing with manned space flight and space exploration. The majority of research areas available for Graduate Student Researchers are in engineering and development, and space and life sciences. Additional information concerning the following opportunities may be obtained from the program administrator.***

## Engineering

**Life Support Systems —** The research area includes: 1) study of advanced physiochemical and biological life support technologies for air revitalization, water reclamation, food production and solid waste management; 2) development of mathematical models for the candidate life support systems for future Moon and Mars missions; and 3) development of automatic control and monitoring techniques at the system level to minimize crew time/effort required for operation of a regenerative life support system.
Contact: Chin Lin
(713) 483-9126

**Regenerative Life Support Systems —** The research area involves development of human life support systems for future long duration missions to the Moon and Mars. Systems are those in which higher plants function as air revitalization (carbon dioxide absorption and oxygen production), water renovation (plant transpiration), and food production. Specific research opportunities include: 1) plant growth in controlled environments; 2) use of solid support substrates (including planetary regolith) for plant growth; 3) waste processing; 4) integration of physiochemical with biological components; and 5) development of monitoring and control systems.
Contact: D. L. Henninger
(713) 483-5034

**Spacecraft Thermal Management Systems —** The research area includes: 1) light weight, high efficiency heat pumps and unique heat rejection devices to aid in room temperature heat rejection in a Lunar or Martian surface environment; 2) high heat flux evaporators and condensers and two-phase flow measurement devices; 3) theoretical studies and analysis techniques for advanced thermal management systems; and 4) automated monitor, control, and fault detection methods for large two-phase heat transport systems.
Contact: E. K. Ungar
(713) 483-9115

**Advanced Extravehicular (EVA) Systems —** The research area includes on-orbit maintenance for astronaut space suits, regenerable portable life support subsystems, associated airlock support systems, and equipment that will enhance EVA safety and productivity.
Contact: M. N. Rouen
(713) 483-9242

**Tracking and Communications —** Research opportunities exist in expert systems for control and monitoring of complex C&T systems, optical and RF sensor systems for autonomous rendezvous and landing operations, efficient multi-access secure systems, programmable digital transmit/receive systems, MMIC distributed array antennas, multi-beam and high-gain electronically steerable antennas, conformal arrays, infrared and optical/laser communications systems, voice recognition systems for control, digital and optical transformation/correlation systems, and end-to-end systems analytical models of C&T systems.
Contact: William E. Teasdale
(713) 483-0126

**Guidance, Navigation, and Control —** Research opportunities exist for definition/development of guidance, navigation, and control systems for space flight programs. These systems include GN&C software algorithms, navigation sensor hardware, and flight control sensor and effector hardware. An advanced technical base is maintained involving test and laboratory facilities and computer simulations to analyze, demonstrate, and test new techniques and concepts. Research opportunities also exist in flight dynamics, aerodynamics/

aerothermodynamics, and computational fluid dynamics.
Contact: Aldo J. Bordano
(713) 483-8177

**Flight Data Systems** — Research opportunities exist for conducting research and system engineering assessments of advanced manned mission data systems. The laboratory provides a research environment for the development and design validation of flight data systems through the use of engineering development tools that include distributed systems, networks, advanced display and control technologies, sensor/effector emulations, integration analyses and system sensitivity studies.
Contact: Robert G. Musgrove
(713) 483-8356

**Propulsion and Power** — Propulsion research: rocket engine combustion and stability, low gravity fluid behavior, high temperature materials, metallized propellant characterization, ceramic applications to small engines and valving, propulsion systems reliability modeling, valving technology, and on-orbit health monitoring. Power research: energy conversion systems, including long life and high current density fuel cells and electrolysis systems, nickel-hydrogen and lithium batteries, photovoltaic and solar dynamic power systems, automated management and distribution, and thermal energy storage.
Contact: Thomas Davies
Power
(713) 483-9041

John Griffin
Propulsion
(713) 483-9003

**Robotic Simulation** — Development of kinematic/dynamic simulations of Shuttle and Space Station telerobots with interactive graphic interfaces is being actively pursued in support of real-time simulation and nonreal-time dynamic analyses. This includes control algorithms for kinematically redundant manipulators, joint servo modeling, control systems interaction, structural contact modeling, and development of simulation architectures. Other areas include multibody dynamic algorithm development (rigid and flexible bodies), friction modeling, and numerical techniques for their solution.
Contact: Charles R. Price
(713) 483-1523

**Artificial Intelligence** — Incorporation of advances in intelligent systems technology into space systems, organizations, and programs for the continual improvement of their effectiveness (safety, reliability, maintainability, cost efficiency, and operability).
Contact: Kathleen J. Healey
(713) 483-4776

**Telerobotics and Autonomous Robotic Systems** — Development of hardware/software upgrades to the Shuttle Remote Manipulator System, the integration of the Space Station Mobile Service Center and the Special Purpose Dexterous Manipulator into the Space Station for long term maintenance, and the development of advanced robotic systems and components to provide adaptive robots for long term autonomous missions in space and on lunar and planetary surfaces.
Contact: Charles J. Gott
(713) 483-8107

**Robotic Applications** — Development of emerging technologies, such as advanced control schemes (i.e., force/torque feedback and adaptive control), multiarm control (for both kinematically sufficient and redundant systems), external sensing, collision detection and avoidance, on-line path planning, remote control of multiple robots at diverse locations, and application of these technologies to mobile platforms and fixed hand manipulators.
Contact: Kathleen J. Healey
(713) 483-4776

**Intelligent Robotics** — Development of dexterous hands/arms to fulfill the future need for autonomous, dexterous robots. Current research efforts include the development of intelligent control systems for arms and hands, coordinated control of dual hand/arm systems, proximity/tactile sensor systems for adaptive grasping and manipulation, and neural networks.
Contact: Charles R. Price
(713) 483-1523

**Computer Graphics Research** — Development of advanced graphics techniques for robotic real-time main-in-the-loop simulation development, as well as for video documentation of robotic scenarios. This includes research and development of algorithms such as radiosity and ray tracing, developing efficient graphics front ends to simulations which must run in real time, animation, geometric modeling, virtual reality, and telepresence.
Contact: Charles R. Price
(713) 483-1523

## Space & Life Sciences

**Biomedical and Nutrition Research** — The present program seeks to define at the cellular and biochemical levels the key elements underlying the integrated physiological response to space flight, with the goals of defining and monitoring crew health and developing countermeasures. Flight-induced changes in fluid and electrolyte balance, orthostatic and cardiovascular function, erythropoiesis, and the musculoskeletal, immunological, and metabolic nutrition systems are being investigated *in vivo* using head-down bed rest, and *in vitro* using cell cultures.
Contact: Helen W. Lane
(713) 483-7188

**Endocrine Biochemistry** — Ongoing projects include *in vitro* and *in vivo* studies of space flight-related perturbations to calcium, carbohydrate, and protein metabolism, sodium homeostasis, and the renin-aldosterone response. Analytical methods are being developed for identifying hormone-binding proteins, antidiuretic hormone, atrial natriuretic hormone, and parathormone. Other methods are being developed to assess electrolytic and hormonal status noninvasively during simulated and actual space flight.
Contact: Peggy A. Whitson
(713) 483-7046

**Immune Responses to Space Flight** — The purported detrimental effect of space flight on the immune system has far-reaching implications for maintaining crew health in space, particularly on long missions. Ongoing projects include characterization of receptors on peripheral-blood monocytes by flow cytometry and image analysis; analysis of the antibody response to microbial challenges *in vitro*; and characterizing changes in microbial physiology as they relate to the risk of infectious disease.
Contact: Duane L. Pierson
(713) 483-7166

**Biotechnology and Bioprocessing** — Microgravity can be used to facilitate the separation and synthesis of medically important biological materials, as well as to enhance the formation of tissue-like aggregates in specially designed bioreactors. Theoretical and experimental projects are under way to improve cell-culture techniques using normal and neoplastic cell types under microgravity conditions.
Contact: Clarence F. Sams
(713) 483-7160

**Pharmacokinetic Research** — Space flight appears to alter the disposition of drugs administered to crew members. Characterizing these changes is essential to design effective treatments for illnesses in flight. Bed-rest and in-flight studies are being conducted to identify the physiological changes that influence drug disposition; to develop simple, noninvasive monitoring procedures that can be used in microgravity; to develop computer models of pharmacokinetics; and to develop appropriate drug-delivery systems.
Contact: Lakshmi Putcha
(713) 483-7760

**Physiologic Research** — The adaptation to space flight can affect human health and performance during space flight and on return to the influence of gravity. The laboratories of the Space Biomedical Research Institute conduct research, involving several physiologic systems (cardiovascular, pulmonary, nervous, and musculoskeletal) to characterize these adaptations. Investigations are conducted both in flight and during ground-based simulations.
Contact: Frederick LaRochelle
(713) 483-8719

**Environmental Physiology/Biophysics Research** — The physiological and biophysical influences and interactions of environmental factors such as gas species and their partial pressures, temperature, gravity, decompression, and exercise are being investigated by the Environmental Physiology Laboratory. Experiments involving human subjects and mathematical models are pursued. The goal is the understanding of physiological problems and developing monitoring equipment. Environmental effects in space missions of several months' duration are now gaining interest.
Contact: Michael Powell
(713) 483-5413

**Psychological Research** — The Behavior and Performance Laboratory conducts investigations to develop effective crew selection, training, and in-flight support procedures and guidelines for manned space missions. Toward this end, specific areas of study include stress and adaptation to extended confinement, team dynamics and leadership, team composition, methods of nonintrusive measurement, cognition, behavioral strategies, behavioral modeling, performance assessment, goal-setting, and preventive mental health.
Contact: A. W. Holland
(713) 483-8482

**Exercise Physiology** — The Exercise Physiology Laboratory is intimately involved in investigations which support much of the other physiological research being conducted in the Space Biomedical Research Institute. The investigators and engineers are also active in the development of contemporary and future flight hardware for extended space flight. A major aim is to understand the degradations in exercise capacity and the role which exercise may play in the maintenance of normal function in other physiologic systems.
Contact: Steven Siconolfi
(713) 483-7110

**Space Food Development** — The Food Systems Engineering Facility supports food development activities for the Shuttle, Space Station, and future missions. Weight and volume of space food systems are critical and projects like Lunar Base and Mars missions require major efforts in food development. Research areas of interest include: food development, acceptability measures for microgravity and isolation, food bioregeneration, shelf life, preservation, packaging, and food waste management.
Contact: Charles T. Bourland
(713) 483-3632

**Space Radiation** — Research in space radiation with the emphasis on the need for crew health protection. The experimental program involves passive dosimetry measurements with thermoluminescent detectors and active dosimetry measurements, which involve development of new charged particle detectors that are flown on the Shuttle. The theoretical program includes the study of and improvements in the trapped radiation belts models, the galactic cosmic radiation models, and studies related to solar energetic particle events.
Contact: Gautam Badhwar
(713) 483-5065

**Orbital Debris** — This theoretical and experimental program includes understanding satellite breakups and other on-orbit sources of orbital debris. Models are developed which combine debris sources with natural sinks to describe the debris environment for both low Earth orbit and geosynchronous orbit. Measurements are conducted of debris physical properties and flux using optical, infrared, radar, and impacted surfaces from returned spacecraft. Hypervelocity guns are used to test spacecraft shielding concepts.
Contact: Donald J. Kessler
(713) 483-5313

**Planetary Materials Analysis** — Research involves laboratory analysis of lunar rocks, terrestrial rocks, meteorites, and cosmic dust particles to unravel the early geochemical history of solid matter in the solar system, the geologic evolution of planets and rocky protoplanetary objects, including comets, and to plan the technology for a lunar base. Remotely sensed data of Earth and other planetary bodies are also used for these same objectives.
Contact: William Phinney
(713) 486-5310

## Safety, Reliability, and Quality Assurance

**Risk Management** — Opportunities exist for research in the development and implementation of quantitative and qualitative techniques to identify the parameters of a comprehensive risk management program for complex space systems and facilities. Approaches include statistical modeling of failures and their effects; probabilistic risk assessment; fault tree, event tree, or decision tree analysis; and the dynamic integration of element hazards arising from both ground and mission phases.
Contact: Richard Holzapfel
(713) 483-4290

## New Initiatives

**Technology Development for New Initiatives** — Identification of performance parameters for specific technologies that are needed for the space exploration program, specifically lunar outpost and Mars missions. Includes revolutionary technologies such as superconductivity, wavelet processors, nano technology, parallel computing, and knowledge-based and intelligent systems. Concepts and designs for hybrid/fused systems to realize weight, size, power, and operational safety advantages.
Contact: Kumar Krishen
(713) 283-5875

## Information Systems

**Advanced Software Technology** — Responsible for developing and evaluating advanced software technology in support of NASA institutional and mission operations. Current efforts include research into general purpose intelligent training systems, expert assistants, neural networks for machine learning and image/speech recognition, parallel/distributed systems, verification/validation techniques, computer aided software engineering (CASE), fuzzy logic, genetic algorithms, planning and scheduling technology, and knowledge capture technology.
Contact: Robert Savely
(713) 483-8105

# *Kennedy Space Center*

*Program Administrator:*
*Mr. Bill J. Martin*
*Manager, University Liaison*
*Mail Stop PT-PAS*
*NASA John F. Kennedy Space Center*
*KSC, FL 32899*
*(407) 867-2512*

*The John F. Kennedy Space Center, located near Cape Canaveral, Florida, is NASA's primary launch site. The center handles the preparation, integration, checkout, and launch of space vehicles and their payloads. Areas of research available for Graduate Student Researchers are in engineering and the Earth Sciences. Additional information concerning the following opportunities may be obtained from the program administrator.*

## Engineering

**Advanced Programs —** Research and engineering efforts related to launch and landing activities for space launch vehicles need technology development capabilities. Include facilities which can withstand the unique environmental conditions on the Atlantic beach side of Florida, and the harsh components of the plume created by liquid and solid fueled rockets. Materials, structures, ground support equipment and development and systems engineering for integrating these components are open for graduate student involvement. Laboratories, equipment, and NASA engineers and managers are available at KSC for these and other opportunities in computer systems programming, network development and management, development of software and artificial intelligence to support the launch environment.
Contact: Tom Davis, Manager
(407) 867-7705
Advanced Systems and Technology Office

## Earth Sciences

**Advanced Programs —** Lightning research, ground flashes, triggering of flashes, simulation with electrostatic generator, and observations made with unique sensor system including electric field mill network, ground flash locating system, VHF pulse observing system; wind, temperature and relative humidity sensors; an array of acoustic sounders and vertical wind profiler. Airborne electric field mill project gathering data in the vicinity of electrified clouds at altitude. Mesoscale numerical modeling and predicting efforts to help predict mesoscale thunderstorm formation.
Contact: James Nicholson
(407) 867-2780
Advanced Systems and Technology Office

Launa Maier
(407) 867-4738
AF RCC Tech Transition Unit

**CELSS Research —** CELSS Breadboard Project includes crop growth and production, chemical allelopathy, microbiological pathology, biomass conversion, and system control and automation. May conduct short-term environmental response tests for community gas exchange and nutrient uptake. Research on carbon exchange rates and carbohydrate metabolism of higher plants in response to gravity. Learn to trace gaseous and microbiological contaminants in a CELSS system. Biomass conversion research in extraction of water-soluble compounds from crop residue, enzymatic hydrolysis of crop residue cellulose, production of edible mycoprotein from glucose, conversion of organic particulates and soluble residues from all other reactors into microbial biomass. Robotic techniques for planting, culturing, and harvesting of crops in closed growth chamber.
Contact: William M. Knott
(407) 853-5142

# *Langley Research Center*

*Program Administrators:*
*Edwin J. Prior*
*Acting University Affairs Officer*

*Robert L. Yang*
*Assistant University Affairs Officer*
*Mail Stop 105A*
*NASA Langley Research Center*
*Hampton, VA 23681-0001*
*(804) 864-4000*

*The mission of the NASA Langley Research Center is to increase the knowledge and capability of the United States in a full range of aeronautics disciplines and in selected space disciplines. The following information provides, by Directorate, an overview of the current disciplines in the Langley program. Specific research activities associated with each discipline are also included.*

## Aeronautics Directorate

The goal of the aeronautics research program is to establish a solid foundation of aeronautical technology and provide a wellspring of ideas for advanced aeronautical concepts. This program includes the following disciplines and specific research activities.

**Fluid Physics** — Subsonic aerodynamics, transonic aerodynamics, high-speed aerodynamics, computational fluid dynamics, turbulent drag and noise reduction, airfoil aerodynamics, advanced test techniques, full-scale Reynolds number test technology, and flight research measurement techniques.

Contact: Edgar G. Waggoner
(804) 864-5055
Subsonic Aerodynamics

Lawrence E. Putnam
(804) 864-2847
Transonic Aerodynamics

David S. Miller
(804) 864-5568
High-Speed Aerodynamics

Ajay Kumar
(804) 864-2285
Computational Fluid Dynamics

Dennis M. Bushnell
(804) 864-5705
Turbulent Drag Reduction

Robert J. McGee
(804) 864-1005
Airfoil Aerodynamics

Lawrence E. Putnam
(804) 864-2847
Full-Scale Reynolds Number Test Technology

**Propulsion** — Propulsion integration, hypersonic propulsion research, and advanced turboprops (noise reduction).

Contact: Bobby L. Berrier
(804) 864-3016
Propulsion Integration
High By-Pass Ratio Turbofans

Griffin Y. Anderson
(804) 864-6236
Hypersonic Propulsion Research

**General Aviation** — Aerodynamics and handling qualities, drag reduction, and separated flow control (stall and spin).

Contact: Luat T. Nguyen
(804) 864-1137
Aerodynamics and Handling Qualities

H. Paul Stough
(804) 864-3860
Separated Flow Control (Stall and Spin)

**High-Speed Aircraft** — Flight dynamics and rocket-borne, small-scale flight research.

Contact: Luat T. Nguyen
(804) 864-1137
Flight Dynamics

**Advanced Aircraft Systems** — Aerodynamics and advanced flight systems.

Contact: Wallace C. Sawyer
(804) 864-6515
Advanced Military Aircraft and Missiles

Samuel M. Dollyhigh
(804) 864-6503
Advanced Aircraft Systems

**Transport Aircraft** — Aviation meteorology research, lightning, severe storms, wake vortex minimization, laminar-flow control, high Reynolds number research, and configuration aerodynamics.

Contact: Bruce D. Fisher
(804) 864-3862
Lightning Severe Storms

George C. Green
(804) 864-5545
Wake Vortex Minimization

Fayette S. Collier
(804) 864-1903
Laminar-Flow Control

Lawrence E. Putnam
(804) 864-2847
High Reynolds Number Research and Configuration Aerodynamics

## Flight Systems Directorate

The goal of the Flight Systems Research Program is to provide, through basic and applied multidisciplinary research activities, advanced technology needed to develop and implement future aerospace flight systems. Research activities include the following disciplines and specific research activities.

**Controls and Guidance** — Fault-tolerant systems, theoretical dynamics and control, crew station technology, and applied control concepts.
Contact: Charles W. Meissner
(804) 864-6218
Fault-Tolerant Systems

Jarrell R. Elliott
(804) 864-4001
Theoretical Dynamics and Control
Applied Control Concepts

Jack J. Hatfield
(804) 864-2012
Crew Station Technology

**Human Factors** — Flight management technology, advanced crew interface research, intelligent cockpit aids research, and pilot workload performance research.
Contact: Sam A. Morello
(804) 864-6664
Flight Management Technology
Advanced Crew Interface Research

Kathy H. Abbott
(804) 864-2018
Intelligent Cockpit Aids Research

Allan T. Pope
(804) 864-6642
Pilot Workload Performance Research

**High-Speed Aircraft** — Aspects of navigation, guidance, and control relative to high-speed aircraft.
Contact: Jarrell R. Elliott
(804) 864-4001
Flight Dynamics and Control

**Transport Aircraft** — Advanced air traffic control; aircraft interaction; airborne detection of wind shear research; and advanced controls, guidance, and flight management research.
Contact: George G. Steinmetz
(804) 864-2042
Advanced Air Traffic Control and Aircraft Interaction
Advanced Controls, Guidance, and Flight Management Research

Roland L. Bowles
(804 ) 864-2035
Airborne Detection of Wind Shear Research

**Computer Science** — Concurrent processing, highly reliable and fault-tolerant computing, automated techniques for systems development, and computing systems design environments including information and data base management techniques and interface definitions for common tool execution environments.
Contact: Wayne H. Bryant
(804) 864-1692

**Space Controls and Guidance** — System identification and adaptive control of large flexible space structures, teleoperator and robotics system technology, and robust and failure-accommodating control design methodology for advanced spacecraft.
Contact: Douglas B. Price
(804) 864-6605
System Identification and Adaptive Control of Large Flexible Space Structures

Jack E. Pennington
(804) 864-6677
Teleoperator/Robotic Systems
Materials and Structures
Automated Construction of Large Space Structures

Douglas B. Price
(804) 864-6605
Robust and Failure Accommodating Control Design Methodology for Advanced Spacecraft

**Electromagnetics, Antennas, and Microwave Systems** — Electromagnetic analysis methods, aircraft and spacecraft antenna technology, far-field and near-field antenna measurements, compact range technology, and microwave remote sensing technology for aircraft and spacecraft applications.
Contact: Thomas G. Campbell
(804) 864-1772

**Electronics and Information Systems** — Laser sensing technology, optical data processing, solid-state memory technology, and very high-speed information processing.
Contact: Harry F. Benz
(804) 864-1493

Jack J. Hatfield
(804) 864-2012
Advanced Control and Display Technology

**Transportation Systems** — Studies leading to algorithms for on-board, real-time guidance, navigation, and control of space transportation systems through launch, maneuvering,

and entry; robust and adaptive guidance schemes that allow for unknown and changing atmospheric conditions; and, simplified and autonomous mission planning.

Contact: Douglas B. Price
(804) 864-6605

Harry F. Benz
(804) 864-1493
Spacecraft Systems Technology
Semiconductor Material Growth in Low-G Environment

## Structures Directorate

The goals of the Structures Directorate cover a wide range of space and aeronautical disciplines. This program includes the following activities.

**Structures (Space)** — Materials and structures, materials for advanced space structures, thermal protection systems for space transportation systems, space structural design methods, space vehicle dynamics, high-temperature space structures, and fatigue and fracture of metal and composites for advanced space transportation systems.

Contact: Brantley R. Hanks
(804) 864-4325
Spacecraft Structural Dynamics
Advanced Flexible Space Structures
Control of Large Flexible Structures

James H. Starnes
(804) 864-2902
Composite Structures for Advanced Space Transportation Systems

Harold G. Bush
(804) 864-3102
Concepts for Advanced Space Structures
Construction of Large Space Structures
Robotics Construction of Large Space Structures

Jaroslaw Sobieski
(804) 864-2799
Integrated Multidisciplinary Analysis Capability for Large Space Structures

Terry L. St. Clair
(804) 864-4273
High-Performance Polymer Concepts
Tough Composite Matrices
Composites Processing and Adhesive Bonding

Charles E. Harris
(804) 864-3449
Fatigue and Fracture of Metals and Composites

Howard G. Maahs
(804) 864-3084
Composite Metals and Coatings
Concepts for Applications in Space Structures

W. Barry Lisagor
(804) 864-3140
Processing and Joining Methods for Light-Weight, Lower Cost Aerospace Structures

Jerrold M. Housner
(804) 864-4325
Computational Structural Mechanics

Charles J. Camarda
(804) 864-5436
Thermal Protection Systems for Space Transportation Systems
High-Temperature Space Structures

**Structures (Aero)** — Materials and structures, structural composites and adhesives, advanced aircraft structures, loads, aeroelasticity and structural dynamics, aeronautical structural design methods, high-temperature aeronautical structures, structural material alloys, and fatigue and fracture of metals and composites.

Contact: James H. Starnes
(804) 864-2902
Advanced Composite Structures

John A. Tanner
(804) 864-1305
Aircraft Safety and Crash Survivability

Allan R. Wieting
(804) 864-1359
Integrated Fluid-Thermal Structural Analysis Techniques
Aerothermal Loads Experimentation

Rodney H. Ricketts
(804) 864-1207
Aircraft Aeroelasticity
Rotorcraft Aeroelasticity

Jaroslaw Sobieski
(804) 864-2799
Multidisciplinary Synthesis Methods for Aerospace Vehicles

Thomas E. Noll
(804) 864-2822
Control of Aeroelastic Response
Aeroservoelasticity

Woodrow Whitlow
(804) 864-2822
Computational Unsteady Aerodynamics Aeroelasticity

Charles E. Harris
(804) 864-3449
Fatigue and Fracture of Metals and Composites

Howard G. Maahs
(804) 864-3084
High-Temperature Structural and Thermal Protection Materials
Advanced Composite Materials for Rotorcraft and Aircraft Structures
Thermal Protection Materials

W. Barry Lisagor
(804) 864-3140
Advanced Light Alloy and Metal Matrix Composites
High-Temperature Thin-Gauge Metal and Metal Matrix Composites

Clemans A. Powell
(804) 864-3575
Interior Noise Control
Acoustic Response
Sonic Fatigue

Jerrold M. Housner
(804) 864-4325
Computational Structural Mechanics

Charles J. Camarda
(804) 864-5436
Aero-Space Plane Propulsion and Airframe Structural Concepts
Thermal Structural Analysis Techniques

**Aeroacoustics** — Supersonic and hypersonic dynamic loads, high-speed rotorcraft noise, advanced turboprop, and computational methods.
Contact: John S. Preisser
(804) 864-3618
Jet Noise Research
Rotorcraft Acoustics
Computational Aeroacoustics

David Chestnutt
(804) 864-5263
Helicopter Acoustics
Propeller Noise
Laminar Flow Acoustics
Noise Propagation

James C. Yu
(804) 864-3640
Low-Speed Aircraft
Rotorcraft Structural Dynamics
Aerodynamics Aeroacoustics

## Electronics Directorate

The mission of the Electronics Directorate is to pioneer and provide technology, systems, and services in the areas of instrumentation, scientific computing, and simulation to sustain Langley's continued research preeminence, and to manage the Center's major aerospace flight research projects. The following items represent active research disciplines.

**Advanced Sensor Systems** — Solid-state laser lidar systems, semiconductor detector, and high-temperature superconductor technologies for spaceflight applications.
Contact: Norman Barnes
(804) 864-1630
Solid-State Laser Technology

William E. Miller
(804) 864-1720
Semiconductor Detector Technology

Leo D. Staton
(804) 864-1793
Lidar Systems Technology

Stephanie A. Wise
(804) 864-8068
High-Temperature Superconductor Technology

**Measurement Science and Instrument Technology** — Far-infrared sensor technology, electromechanical sensors, digital data systems, nonintrusive optical and laser measurements, optical and laser spectroscopy, mass spectrometry and gas chromatography, thermal measurements, structural dynamics and acoustics measurements, optical interferometry and photogrammetry techniques, and electronics applications.
Contact: Ira G. Nolt
(804) 864-1623
Far-Infrared Sensor Technology

Richard R. Antcliff
(804) 864-4606
Nonintrusive Measurements
Thomas A. Shull
(804) 864-1837
Advanced Electronics Optical Data Storage

Harlan K. Holmes
(804) 864-4650
Electromechanical Sensors
Structural Dynamics and Acoustics Measurements

Robert L. Krieger, Jr.
(804) 864-4654
Digital Data Acquisition

Reginald J. Exton
(804) 864-4605
Optical and Laser Spectroscopy

Billy T. Upchurch
(804) 864-4750
Mass Spectrometry and Gas Chromatography

Philip Brockman
(804) 864-1554
Solid-State Laser Systems

Ira G. Nolt
(804) 864-1623
Far-Infrared Sensors

Glen W. Sachse
(804) 864-1566
In Situ Diode Laser Sensors

Tom A. Shull
(804) 864-1837
Advanced Electronics

Jerry H. Tucker
(804) 864-7342
Microelectronics and Microprocessors

Kamran Daryabeigi
(804) 864-4745
Thermal Measurements

John C. Hoppe
(804) 864-4618
Optical Interferometry
Photography

**Materials Characterization Technology** — Ultrasonic propagation and scattering in composites, ultrasonic arrays, signal processing, image analysis, nonlinear acoustics, electron microscopy, microstructural physics, elastic behavior, X-ray tomography, fiber optic sensors, and electronics reliability.
Contact: Eric I. Madaras
(804) 864-4993
Ultrasonic Propagation and Scattering in Composites

Patrick H. Johnston
(804) 864-4966
Ultrasonic Arrays
Signal Processing
Image Analysis

William P. Winfree
(804) 864-4963
Thermal Wave and Diffusion Analysis

John H. Cantrell
(804) 864-4989
Nonlinear Acoustics
Elastic Behavior
Electron Microscopy
Microstructural Physics

Min Namkung
(804) 864-4962
X-ray Tomography for Stressed Solids

Robert S. Rogowski
(804) 864-4990
Fiber Optic Sensors for Structural Dynamics

Joseph S. Heyman
(804) 864-4970
Electronics Reliability Sciences

**Advanced Computational Capability** — Piloted simulation, computer-generated scientific visualization, image processing, grid generation, and numerical techniques for high-performance scientific computers.
Contact: Billy R. Ashworth
(804) 864-6449
Piloted Simulation
John E. Hogge
(804) 864-6705
Scientific Visualization
Image Processing

Jay J. Lambiotte
(804) 864-5794
Grid Generation
Numerical Techniques for High-Performance Scientific Computers

## Space Directorate

The goal of the space and atmospheric science research and technology program is to establish and maintain a solid foundation of technology embracing all of the disciplines associated with space and atmospheric sciences and to provide a wellspring of ideas for advanced concepts. This program includes the following disciplines and specific research activities.

**Stratospheric Aerosol and Gas Experiment (SAGE)** — Analysis and interpretation of atmospheric aerosols, ozone, nitrogen dioxide and water vapor measured from SAGE I (1979-81) and SAGE II (1984-present) satellite instruments.
Contact: Lamont R. Poole
(804) 864-2689

**Climate Research Program** — Theoretical, laboratory, and field investigations of the chemical and radiative properties of natural volcanic and man-made aerosols and assessment of their impact on regional and global climate. Remote and *in situ* observations of cloud properties and radiation balance components and theoretical studies of the role played by clouds in the Earth's radiation balance.
Contact: Patrick Minnis
(804) 864-5671

**Tropospheric Chemistry Research Program** — Assess and understand human impact on the regional-to-global-scale troposphere; define chemical and physical processes governing the global geochemical cycles from empirical and analytical modelling studies, laboratory measurements, technology developments, and field measurements; and, exploit unique and critical roles that space observations can provide.
Contact: James M. Hoell, Jr.
(804) 864-5826

**Upper Atmospheric Research Program** — Expand the scientific understanding of the Earth's stratosphere and the ability to assess potential threats to the upper atmosphere. Includes developing empirical and theoretical models, formulating new instruments and techniques, performing laboratory and field measurements, and performing data analysis and interpretation studies.
Contact: William L. Grose
(804) 864-5820

**Measurements of Air Pollution From Satellites (MAPS)** — Analysis and interpretation of measurements from an instrument developed to provide global tropospheric carbon monoxide data from the unique vantage of the Space Shuttle, with the opportunity for frequent flights.
Contact: Henry G. Reichle Jr.
(804) 864-5383

**Earth Radiation Budget Experiment (ERBE)** — Analysis of measurements from instruments on three satellites that provide data on the Earth's radiation budget for assessing climatic impact of human activities and natural phenomena as well as a

better understanding of all climatic parameters, in particular, the radiation budget components on a global scale.
Contact: Bruce R. Barkstrom
(804) 864-5676

**Analysis and Interpretation of Constituent and Temperature Data for the Middle Atmosphere —** Studies of chemical and dynamical processes in the stratosphere by using interpretive analysis of remote sensing data from satellites.
Contact: Ellis E. Remsberg
(804) 864-5823

**Halogen Occultation Experiment (HALOE) —** Analysis and interpretation of measurements from this experiment on the Upper Atmosphere Research Satellite to improve understanding of stratospheric ozone depletion, particularly the impact of chlorofluoromethanes on ozone by analyzing global vertical profile data of $O_3$, HCl, $CH_4$, $H_2O$, NO, $NO_2$, and HF.
Contact: John G. Wells
(804) 864-1859

**Entry Fluid Physics —** Computational fluid dynamics, entry vehicle aerothermodynamics and configuration technology, planetary mission support technology, and aerodynamic and aerothermodynamic flight data analysis.
Contact: Kenneth Sutton
(804) 864-4406

**Transportation Systems —** Future space vehicle concept development, operations, research, and computer-aided design.
Contact: Delma C. Freeman
(804) 864-4502

**Space Systems Technology —** Spacecraft concept development studies for Global Change science missions; large Earth orbiting spacecraft and platform systems studies; spacecraft subsystem analyses; performance and technology assessments; lunar and Mars mission studies; astronaut space radiation dose and shielding analyses; mission design; and computer-aided design and simulations.
Contact: L. Bernard Garrett
(804) 864-4425

**Aerodynamic and Aerothermodynamic Experiments —** Experimental assessment and enhancement of hypersonic aerodynamic, aerothermodynamic, and fluid dynamic characteristics of future Earth and planetary aerospace vehicle concepts.
Contact: Charles G. Miller
(804) 864-5221

**Space Systems Technology —** Spacecraft concept development studies for Global Change science missions; large Earth orbiting spacecraft and platform systems studies; spacecraft subsystem analyses, performance, and technology assessments; Lunar and Mars mission studies; astronaut space radiation dose and shielding analyses; mission design; and, computer-aided design and simulations.
Contact: L. Bernard Garrett
(804) 864-4425

**Configuration Definition for the Evolution of Space Station *Freedom* —** Study of the required augmentations to Space Station *Freedom* to accommodate future users such as the Lunar and Mars mission.
Contact: William M. Cirillo
(804) 864-1938

**Subsystem Growth Requirements for Space Station *Freedom* —** Definition of the requirements on the Space Station's distributed systems to allow station growth beyond the baseline configuration.
Contact: Donald W. Monell
(804) 864-7515

**In-Space Technology Experiments —** Definition and development of flight experiments for the verification and validation of unique, innovative space technologies in the space environment or under microgravity conditions.
Contact: Joseph C. Moorman
(804) 864-3776

**Aerobraking —** Identification of applications in manned and robotics missions. Assessment of current technology readiness and development of plans for satisfying new technology requirements.
Contact: E. Brian Pritchard
(804) 864-8200

**First Lunar Outpost —** Mission and systems analyses to define implementation approaches that maximize the use of current technology. Define new technology requirements.
Contact: Davy A. Haynes
(804) 864-8214

**Lunar Rover Robotics Missions —** Identify design concepts for mini-rovers capable of supporting small site characterization instruments. Identify potential instrument concepts and rover support requirements.
Contact: Vernon P. Gillespie
(804) 864-8209

**Space Exploration Initiative —** Mission and systems analyses to select appropriate mission architectures, define technology needs, identify mission implementation options, and select Langley Research Center mission hardware roles for the Moon and Mars missions.
Contact: James L. Raper
(804) 864-8200

**Advanced Propulsion Technology —** Experimental physics and engineering of radiation and plasma propulsion concepts, which includes plasma generation, acceleration, characterization and modeling.
Contact: Edmund J. Conway
(804) 864-1435

## Systems Engineering and Operations Directorate

The Systems Engineering and Operations Directorate, organized into five Divisions and a facilities planning office, consists of approximately 1,050 multidisciplined engineering and technical support personnel providing the engineering design and fabrication of flight hardware and research test articles and equipment; the planning and implementation of the Construction of Facilities program; the operation and maintenance of research laboratories and wind tunnels; all institutional services; and the direction of the safety, quality, reliability programs, and the energy and environmental programs, in support of the aeronautical and space research pro-grams of the Langley Research Center.

**Systems Engineering** — Opportunities to develop mechanical systems for advanced remote sensing instruments engaged in atmospheric science research. Specific areas of opportunity include electro-mechanical component design and development, thermal control system development, structural system design and analysis, precision optic bench development, precision point and control systems, and mechanisms development. Opportunities are also available for developmental and environmental test engineering of aerospace technology experiments to be flown on the National Space Transportation System (Shuttle), and for developing integrated engineering design and analysis (computer aided engineering) systems.
Contact: Ralph J. Muraca
(804) 864-7004

**Facilities Engineering** — Engineer and design aerospace research facilities and equipment for aeronautical and space research including: wind tunnel structures and systems, test sections, model supports, environmental chambers, heaters, coolers, mechanical drives, electrical drive machinery, and electrical distribution systems. High temperature aerodynamic research for the National Aerospace Plane (NASP) in the 2.4-meter High Temperature Tunnel, low temperature aerodynamic research in the National Transonic Facility, magnetic suspension control systems in the Active Control Test Facility, and landing loads at the Aircraft Landing Dynamics Facility.
Contact: Sammie D. Joplin
(804) 864-7291

**Engineering and Design** — Engineering and design of aeronautical and space research facilities. A new high-performance combustor for the 2.4-meter High Temperature Tunnel is being planned. New analytical methods to predict and understand the explosion dynamics associated with confined combustion processes at high pressures; accounting for fast flame propagation in variable reactive compositions are needed to provide the designers with reasonable estimates of explosion pressures.

Also needed is an experimental plan to validate the analytical methods identifying all critical parameters.
Contact: Carl E. Gray, Jr.
(804) 864-7214

**Structural Engineering** — Structural finite element modeling; dynamic structural analysis; heat transfer and fluid flow; combustor dynamics; fluid mechanics; and heat transfer processes. Evaluation and creation of analytical methods for the combustion process system for the 2.4-meter High Temperature Tunnel. Analysis and creation of empirical formulas for the fluid dynamics associated with the Aircraft Landing Dynamics Facility.
Contact: David C. Beals
(804) 864-7179

**Engineering Laboratory Unit** — Physical and chemical analytical testing services needed for the operation of facilities at Langley. Development of analytical instrumentation that will advance services at Langley or will advance technology in aeronautics and space projects. Examples are inorganic and organic instrumentation for environmental controls; inorganic analysis by X-ray Fluorescence for wear-metal analysis in lubricants, for water quality monitoring; and, geological analysis on planetary rovers.
Contact: Warren C. Kelliher
(804) 864-4172

# *Lewis Research Center*

*Program Administrator:*
*Dr. Francis J. Montegani*
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*The Lewis Research Center has a broad research program embracing aeronautical propulsion, space propulsion and power, space electronics, and microgravity science. Brief descriptions of some of the major research activities at Lewis follow.*

## Aeropropulsion Analysis

**Aircraft Propulsion Systems Analysis —** Advanced propulsion concepts are conceived and analyzed to estimate performance for typical flight vehicle applications, determine relative merits compared with alternative propulsion systems, and derive optimum designs of systems integrated with a vehicle. Also, analytical and numerical models that predict performance, noise, and weight of complete propulsion systems and components are developed, along with models of flight vehicles.
Contact: Daniel C. Mikkelson
(216) 977-7011

## Instrumentation and Controls Technology

**Controls and Dynamics —** Advanced digital electronic and fiber-optic-based controls and systems are developed for air breathing and rocket engines, motivated by increased performance, operability, and durability requirements. Included in the scope of the research are control theory applications, real-time flight/propulsion simulation, integrated flight/propulsion controls, system life-extending controls, fiber-optic and electro-optic control components, and robust fault-tolerant controls and systems. Application of neural networks to controls and advanced dynamic modeling and modeling methodologies are active research areas also.
Contact: Norman C. Wenger
(216) 433-3730

**Instrumentation and Sensors —** Instrumentation and sensor technology is developed for aerospace propulsion R&D requirements and propulsion and flight control applications. For propulsion R&D requirements, emphasis is on laser-based techniques for nonintrusive gas path diagnostics and structures measurements, and on thin film sensor technology for temperature, heat flux, and strain measurements. For propulsion and flight control applications, emphasis is on optical and electro-optical sensors and systems.
Contact: Norman C. Wenger
(216) 433-3730

**High Temperature Electronics Technology —** Development of silicon carbide-based, solid-state electronic device technology for high temperature, high radiation, and high power applications, such as advanced aerospace propulsion and power systems. Basic and applied research efforts include silicon carbide crystal growth techniques and all areas of device fabrication technology.
Contact: Gary T. Seng
(216) 433-3732

## Internal Fluid Mechanics

**Computational Fluid Mechanics —** Development and application of new techniques for analysis of subsonic, supersonic, and hypersonic aerospace propulsion system flows associated with inlets, nozzles, compressors, turbines, combustors, augmentors, and rocket systems. Research is also conducted in the numerical simulation of fluids in the space environment, including such phenomena as rarefied gas flows, microgravity effects on free surfaces, g-jitter effects on fluid mixing, and microgravity combustion. Emphasis is on numerical methods with greater accuracy and significantly increased convergence rates. Of increasing importance are computational strategies using such concepts as multiblock grids and zonal approaches combining two or more numerical methods. Pacing items for advanced applications are three-dimensional complex geometry mesh generation techniques, grid lattice construction, and solution-adaptive

mesh clustering. Three-dimensional turbulent flow fields with emphasis on turbulence models are of continuing interest. An expanded and focused effort on developing, validating, and applying advanced turbulence models for propulsion flow physics is a growing research activity.
Contact: Lonnie Reid
(216) 433-3606

**Computational Technology —** Development and application of advanced computer hardware and software to the simulation of flows associated with aerospace propulsion components and systems. Included in the scope of the research is the synthesis and benchmarking of parallel computer architectures and algorithms for solving 3-D steady and unsteady flow problems, the use of expert systems as intelligent interfaces to large computer codes, the use of parallel processing and interactive graphics techniques for on-line visualization of computational results, and experimental data and improved data handling software for distributed computing environments.
Contact: Lonnie Reid
(216) 433-3606

**Experimental Fluid Mechanics —** Experiments to verify selected fluid mechanics computations and to advance understanding of flow physics, heat transfer, and combustion processes fundamental to aerospace propulsion. Experimental data are analyzed to aid development of aerothermodynamic models embracing combustion thermodynamics, reaction chemistry, and turbulence. State-of-the-art experimental facilities, instrumentation, and data acquisition, reduction, and analysis methods and facilities are employed.
Contact: Lonnie Reid
(216) 433-3606

## Aeronautical Propulsion Systems

**Hypersonic Propulsion Technology —** Analytical and experimental research directed at the aerodynamic design of hypersonic propulsion systems and their integration with the airframe. Work includes analysis and test of inlets, nozzles, combustors, and other critical components. Experimental efforts include design of models and instrumentation. New theoretical flow analyses, which include 3-D shock/boundary layer interactions, are applied to the design and evaluation of experiments.
Contact: John E. Rohde
(216) 433-3949

**Emissions Technology —** Experimental and analytical research to advance the understanding of emissions formation in combustion processes in subsonic and supersonic aircraft engines. Experiments include taking measurements in flame tube combustors using advanced diagnostics. Analytical work involves using KIVA II and LERC-3-D computer codes to predict combustion emissions and compare with ongoing experimental results. State-of-the-art experimental facilities, instrumentation and analysis methods, and computational facilities are employed.
Contact: Richard W. Niedzwiecki
(216) 433-3407

**Aircraft Icing —** Analytical and experimental efforts devoted to developing novel concepts for aircraft ice protection, and fundamental experiments to understand and model the physics of ice formations. Changes in aircraft performance with ice buildup on unprotected components are quantified. Extensive aerodynamic and thermodynamic numerical models are developed and utilized. Interdisciplinary efforts are devoted to developing instruments to characterize icing cloud properties, measure ice accretion on surfaces, and detect changes in aircraft performance in icing conditions. Experimental research is conducted with a specially equipped Twin Otter aircraft and in the Lewis Icing Research Tunnel, the largest refrigerated icing tunnel in the world.
Contact: John J. Reinmann
(216) 433-3900

**Aircraft Power Transfer Technology —** Power transfer technology for advanced propulsion drive systems having higher power-to-weight ratio, longer life, higher reliability, lower noise, and higher efficiency. Areas under study include design optimization, new gear arrangements and tooth forms, materials, lubrication, and cooling. New analytical tools for stress analysis, vibration, lubrication, and high-speed gears are being developed. A full-scale helicopter transmission test rig is available, as are facilities for fundamental studies of lubrication, endurance, efficiency, noise of spur and bevel gears, and planetary gear sets.
Contact: John J. Coy
(216) 433-3915

**Low Noise Nozzle Technology —** Analytical and experimental research on exhaust nozzle aerodynamics and acoustics for high speed commercial transport applications. The goal is to achieve takeoff noise levels competitive with the best subsonic engine technology. Advanced 3-D full Navier Stokes computational methods are used for nozzle flow analysis and performance predictions. Acoustic analyses utilize time and frequency domain acoustic analogy models in conjunction with aerodynamic predictions. The more promising nozzle concepts are evaluated experimentally in large dedicated facilities where aerodynamic performance, near and far field acoustic performance, and flow details via advanced flow diagnostics can be determined.
Contact: Bernard J. Blaha
(216) 433-3933

**Turbine Engine Technology —** Research to advance gas turbine engine technology for a wide range of civil and military applications. Areas addressed include advanced cycles involving regenerators and recuperators, advanced compressors, combustors, and turbines, and application of ceramic materials. Research on other propulsion system components, such as inlets, ducts, and nozzles, is included. Involved are flow visualization, computer code development, performance modeling, and thermal and mechanical technologies.
Contact: Lawrence J. Bober
(216) 433-3944

**Fan/Propeller Aerodynamics and Acoustics —** Analytical and experimental investigations of the aerodynamics and acoustics of advanced fans/propellers for flight Mach numbers to 0.8. Advanced lifting line and finite difference lifting surface methods are applied to the prediction of flow fields and performance. Noise predictions are made using time and frequency domain acoustic analogy models in conjunction with aerodynamic predictions. New fan/propeller concepts are evaluated analytically, and the more promising are evaluated experimentally for performance and noise characteristics.
Contact: John F. Groeneweg
(216) 433-3945

**High Performance Aircraft Propulsion Technology —** Research on propulsion systems for advanced high performance aircraft, including highly maneuverable fighters and short takeoff/vertical landing fighters. Included are theoretical analyses and experimental investigations of individual components and complete systems. Highly integrated flight propulsion control systems are a special area of investigation. Novel propulsion concepts are evaluated and research is performed to develop key technologies. Research includes analytical studies, application of advanced design codes, and planning and execution of experimental programs.
Contact: Robert E. Coltrin
(216) 433-2181

## Interdisciplinary Technology

**High Performance Computing and Communications/Numerical Propulsion Simulation —** Development of a propulsion system simulation involving the integration of disciplines, components, and high-performance computers into a high-level software environment. Of particular interest is the structuring of object-oriented component models within a data flow control network. The numerically intensive component models will employ various parallel processing strategies to speed the overall system processing times. Various algorithms will be explored to solve complex-geometry, time-varying, engine system problems on a heterogeneous network of computers.
Contact: Russell W. Claus
(216) 433-5869

## Materials

**Microgravity Materials Science —** Fundamental research to understand the effect of gravity on materials processing as it influences convection, buoyancy, sedimentation, and hydrostatic pressure. Central to this effort is the Microgravity Materials Science Laboratory, which is used by scientists to develop experiments for eventual flight on the Space Shuttle. The laboratory develops advanced flight hardware and supporting equipment for processing and analysis of metals, ceramics, glasses, and polymers. Areas of research include directional solidification, telerobotic control, flow diagnostics, macro- and micro-segregation, undercooling, sol-gel and containerless processing, and crystal growth. A significant portion of this effort is being directed to computational modeling of growth processes as they are influenced by gravity. The laboratory includes an extensive computational and graphical display facility.
Contact: Thomas K. Glasgow
(216) 433-5013

**Ceramic-Matrix Composites —** Development of structure/processing/property relationships of ceramic-matrix composites including fibers and fiber coatings for high-temperature, high-reliability requirements for advanced aerospace propulsion and power applications. New processing approaches, including polymer pyrolysis, chemical vapor deposition, and sol-gel processing, are being pursued. Properties of interest include flaw distribution, phase morphology, strength, toughness, crack initiation and propagation characteristics, and resistance to environmental attack.
Contact: Stanley R. Levine
(216) 433-3276

**Tribology —** Research to gain a fundamental understanding of the lubrication, adhesion, and wear phenomena of materials in relative motion that meet increased speed, load, and temperature demands of advanced aerospace propulsion and power systems. Both synthesized liquid lubricants and solid lubricants created by plasma film deposition techniques are under study. Tribological behavior is investigated *in situ* using a variety of techniques including Auger electron and X-ray photoelectron spectroscopy.
Contact: Stephen V. Pepper
(216) 433-6061

**Polymers and Polymer Matrix Composites —** Development of advanced polymers and polymer matrix composites for use in aerospace propulsion and power and space communications systems. Areas of

research include polymer synthesis, characterization, and processing; composite processing, characterization and evaluation; interface studies; polymer/composite aging and life prediction; and determination of structure/property relationships. Research is interdisciplinary and involves work in organic and polymer chemistry, physics, chemical engineering, materials science and engineering, and mechanical engineering.
Contact: Michael A. Meador
(216) 433-3228

**Environmental Durability of Advanced Materials** — Research to understand the mechanisms of material degradation and to develop approaches to improve the durability of material systems for advanced turbine engines. Of particular interest are high temperature chemistry, environmental effects and the development of coatings for metals, intermetallics, and ceramics and their composites. Chemical vapor deposition (CVD), physical vapor deposition, and plasma spray processes are used in developing coatings. Modeling efforts complement experimental activities in CVD and in environmental degradation studies.
Contact: Leslie A. Greenbauer-Seng
(216) 433-6781

**Metal Matrix and Intermetallic Matrix Composites** — Development of advanced materials, such as intermetallic compounds and refractory metals, and innovative processing concepts, such as rapid solidification, arc spraying, and laser fiber growth, for application to aerospace propulsion systems and space power systems having improved performance, higher temperatures, greater durability, and lower cost. Microstructure/property relationships are being developed and experimentally verified. Advanced analytical and microscopy techniques are employed.
Contact: Michael V. Nathal
(216) 433-3197

Robert V. Miner, Jr.
(216) 433-3270

## Structures

**Advanced Composite Mechanics** — Research for development of theories, computational algorithms, and requisite computer codes for the mechanics, analysis, and design of propulsion structures made from high temperature composites. Of interest are polymer matrix, metal matrix, ceramic matrix, and carbon-carbon composites. Research focuses mainly on specialty finite elements for micromechanics and laminate theory; improved theories for life and durability prediction under hostile environment and long time exposure effects; probabilistic composite mechanics; and integrated computer programs for component-specific analysis and design, progressive fracture, acoustic fatigue, damping, and high-velocity impact. Selective experimental research is conducted in support of theoretical developments.
Contact: Christos C. Chamis
(216) 433-3252

**Concurrent Engineering Simulation** — Research for developing integrated software packages for the computational simulation of multidisciplinary procedures through which propulsion structural systems are developed, conceived, designed, fabricated, verified, certified, installed, and operated (concurrent engineering). Of interest are simulation models and software packages which consist of: (1) workstations with discipline-specific modules, dedicated expert systems, and local databases; (2) a central executive module with a global database and with communication links for concurrent interaction with the multidiscipline workstation; (3) unsupervised-learning neural nets; (4) adaptive methods for condensing and incorporating information as the system evolves; (5) zooming methods; (6) graphic displays; and (7) computer-generated tapes for numerically controlled fabrication machines.
Contact: Christos C. Chamis
(216) 433-3252

**Probabilistic Structural Mechanics** — Research for developing probabilistic structural mechanics, solution/computational algorithms, and requisite computer codes to quantify uncertainties associated with the parameters and variables required for structural analysis and design for both serial and parallel composites. Research focuses mainly on developing probabilistic theories and models for coupled thermal-mechanical-chemical-temporal structural behavior of propulsion structures made from high temperature materials and including metal matrix, ceramic matrix, and carbon-carbon composites and implementation in serial and parallel machines.
Contact: Christos C. Chamis
(216) 433-3252

**Computational Structures Technology** — Development of technology and methodology for the analysis and design of propulsion and power structural systems. Areas of interest are simulation, computational mechanics, design optimization, and artificial intelligence to improve propulsion and power systems structural analysis and design. Simulation includes object-oriented technology, real-time process control, distributed computing, virtual reality, and human interfaces. Computational mechanics includes fundamental mechanics principles, discrete solution methods, and parallel algorithms. Design and optimization includes mathematical programming and optimality algorithms, heuristic methodology, and multidisciplinary design. Artificial intelligence includes expert systems and neural network applications.
Contact: Dale A. Hopkins
(216) 433-3260

**Structural Analysis and Life Prediction** — Development of structural analysis methods for advanced aerospace propulsion and power systems. Areas of consideration include finite element modeling, aeroelasticity, rotor and structural dynamics, fracture mechanics, life prediction, modeling of advanced materials including fibrous composites, micromechanics of high temperature fatigue, and damping. Analytical and experimental efforts are devoted to nonlinear constitutive relations for predicting the behavior of materials and components under varying loads and temperatures. Other topics include crack propagation and fracture criteria for mixed mode loading and variable temperature, transient thermal growth, and thermal bowing and its effects on clearances and unbalance.

Contact: John L. Shannon, Jr.
(216) 433-3211

**Structural Dynamics** — Development of fundamental methods for predicting and controlling the dynamic response and stability of aerospace propulsion and power systems. High-speed rotation provides a central focus for much of the work. This includes studies of the aeroelastic response of bladed disk systems, both active and passive methods for controlling the vibration and stability of high-speed rotor-shaft systems, and modal analysis methods for highly damped large scale periodic structures. Actively controlled bearing supports are being developed to allow higher speed and lighter weight aeropropulsion system design. Technology for long life mechanical components for space mechanism designs to enable long duration space missions. Innovative computational methods that exploit parallel computers and modern computer science principles are being applied.

Contact: L. James Kiraly
(216) 433-6023

**Structural Integrity** — Research to assure integrity and reliability of aerospace propulsion and power systems and structural components. Areas of emphasis include interrogational methods for avoiding catastrophic fracture, fault-tolerant design, defect assessment, and residual life prediction. Comprehensive life prediction models are sought that incorporate complex stress states, nonlinear material characteristics, microstructural inhomogeneities, and environmental factors. Structural integrity is verified by nondestructive characterization of microstructure, flaw population, material morphology, and other relevant factors. Nondestructive evaluation is carried out using analytical ultrasonics, computed tomography, laser acousto-ultrasonics, and other advanced interrogational technologies. Modern computer science practices are exploited to the fullest, and emphasis is on advanced structural ceramics and composites. Integrated computer programs for predicting reliability and life of brittle material components are generated.

Contact: John P. Gyekenyesi
(216) 433-3210

## Space Propulsion Technology

**Liquid Rocket Propulsion** — Research to better understand the basic physical and chemical processes in liquid rocket engines. Disciplines include high-energy propellant chemistry, ignition, combustion, heat transfer and cooling in thrust chambers, nozzle flow phenomena, and performance. Of particular interest are the fundamentals involved in combustion, cooling, bearings, seals, expert systems applications to propulsion, and nonintrusive diagnostics. Work is conducted through detailed analytical and experimental programs to determine feasibility or applicability and to develop and validate models to describe the processes.

Contact: Ned P. Hannum
(216) 977-7506

**Rocket Engine System Monitoring** — Research to develop improved and automated methods for detection and isolation of anomalous behavior of rocket engines. Efforts are currently focused on the Space Shuttle Main Engine, and an Advanced Safety System and a Post-Test Diagnostic Expert System are being developed. Research opportunities include development of qualitative and quantitative models for failure signature prediction, application of pattern recognition techniques for a fault diagnosis, and construction of expert systems and user interfaces.

Contact: Sol H. Gorland
(216) 977-7561

**Low Thrust Propulsion Fundamentals** — Research on electric and chemical propulsion concepts that are candidates for a broad range of low-thrust, space propulsion functions. The electric propulsion effort includes arc jets and a variety of advanced plasma rockets. The low-thrust chemical propulsion effort is focused on very high-performance storable and hydrogen/oxygen rockets at thrust levels up to about 100 pounds. Efforts are directed toward understanding the fundamental phenomena of the various concepts.

Contact: David C. Byers
(216) 977-7543

**Molecular Computational Fluid Dynamics** — Research on molecular computational fluid dynamics for the plumes, nozzles, and higher density plasma and combustion zones of low-thrust chemical and electric propulsion concepts. Efforts include research on (1) improved computational concepts, including effective use of parallel processing; (2) advanced physics models, including trades between interaction physics and speed of calculations; and (3) experimental tests to assist in devel-

opment and validation of codes. Both neutral and charged flows will be studied to both describe and, where appropriate, assess the impact of those flows on spacecraft functions and subsystems.
Contact: David C. Byers
(216) 977-7543

## Power Technology

**Photovoltaic Space Systems —** Fundamental and applied research to increase the efficiency, reduce the weight, and extend the life of solar cells for space applications. Emphasis is on III-V compounds, i.e., InP and GaAs. However, amorphous silicon and other thin film materials systems are also of interest. Activities include materials studies; investigations of radiation damage effects; device design, fabrication, and testing; and the development of related component technologies such as interconnects and optical concentrators.
Contact: Dennis J. Flood
(216) 433-2303

**Electrochemical Space and Storage** — Development of advanced technology to increase the life and energy density of energy storage systems and fuel cells. Emphasis is on nearer-term nickel-hydrogen and hydrogen-oxygen regenerative fuel cell systems, with exploratory efforts being given to more advanced high-temperature ionic conductor systems. Pre-prototypes of advanced battery systems are being designed, built, and tested.
Contact: Marvin Warshay
(216) 433-6126

**Space Power Management and Distribution Technology —** Development of technology to control the generation and distribution of electrical energy in aerospace systems and to define enabling technology for future high-power aerospace systems. The program includes the investigation of advanced electrical power circuits and the fundamental physics of electrical devices (insulators, conductors, and semiconductors). Prototype devices and circuits are fabricated and performance characterized and analyzed. Research in system autonomy, system architecture, and fault prediction are important elements of the program.
Contact: Robert W. Bercaw
(216) 433-6112

**Power Systems Technology —** Development of technology for efficient, compact, lightweight, long-life nuclear space power systems for a variety of applications over a range from hundreds of watts to tens of megawatts, and power generation, energy storage, and electrical power management technology for extraterrestrial solar surface power systems. System and mission application studies for nuclear and solar space power systems are conducted to identify requirements and technology needs in the areas of energy conversion, thermal management, power conditioning and control, materials and environmental effects.
Contact: John M. Smith
(216) 433-6130

**Stirling Dynamic Power Systems —** Development of technology to exploit the unique potential of the Stirling engine for both space and terrestrial applications. Principal emphasis is on developing the free-piston Stirling engine for high-capacity space-power generation systems. Among the areas of research are oscillatory flow and heat transfer, advanced instrumentation, heat pipes, high temperature materials, noncontacting bearings, dynamic balancing systems, and hydraulic and linear alternator power takeoff systems.
Contact: James E. Dudenhoefer
(216) 433-6140

**Space Environmental Interactions** — Research on electrostatic and electromagnetic effects induced in space systems and instrumentation by interaction with space plasma and field environments and on the development and characterization of local plasma and field environments around large space systems. Such effects include surface and bulk dielectric charging, plasma sheath development and characteristics, current collection from plasma, arcing, and the stimulation and propagation of disturbances. Research disciplines involved include plasma, solid-state, and surface physics, electromagnetism, and fundamentals of space system design.
Contact: Carolyn K. Purvis
(216) 433-2307

**Power Materials Technology —** Development of new or improved environmentally durable power materials, high emittance radiator surfaces, high reflectance or transmittance solar concentrators, high thermal conductivity materials, and high electrical conductivity composites. Evaluations of functional performance and durability are conducted for exposure to atomic oxygen, ultraviolet radiation, vacuum thermal cycling, and effects of interactions with lunar and Martian dust.
Contact: Bruce A. Banks
(216) 433-2308

**Solar Dynamic Systems for Space Power** — Development of advanced technology for lightweight, high efficiency solar dynamic space power systems. A solar concentrator high specular reflectance and high surface optical efficiency minimizes mass and adds to high system efficiency. Concentrator material compatibility with space environment (vacuum, atomic oxygen, radiation, etc.) is needed for long life. The development of a heat pipe cavity heat receiver with thermal energy storage

will reduce the size and weight of the power system. Ground testing of a 2 kWe solar dynamic Brayton space power system under simulated space vacuum will evaluate component and system performance.
Contact: James E. Calogeras
(216) 433-5278

**Thermal Management Technologies for Space Power Systems —** Analytical and experimental efforts to develop low mass, high performance heat transport systems and components for space power heat rejection and thermal control of power electronics. Concepts under investigation include ultra-high conductivity micro heat pipe radiator fins, direct immersion heat pipes for cooling electronics, and a vapor pressure pumped heat transport loop. Innovative concepts, such as micro fluid pumps with no moving parts, are also being explored.
Contact: James E. Calogeras
(216) 433-5278

## Space Communications Technology

**Aerospace Applications of High Temperature Superconductivity —** Research to assess the potential payoff for aerospace applications of high-temperature superconductivity, to define the technology requirements for these applications, and to develop the requisite technology. Emphasis will be placed on the large scale applications generally involving high currents, high magnetic fields, and substantial energy storage or power transmission.
Contact: Denis J. Connolly
(216) 433-3503

**Space Communications Systems Analysis —** Studies of advanced space communications to define future system concepts and technology requirements. Studies include investigation of new communications system architectures and networking concepts, comparison of advanced satellite and terrestrial systems, and exploration of new ways to increase the available spectrum/orbit communications capacity. Involved are computer modeling of systems of satellites and simulation of communications links. Laboratory research is conducted on digital television coding to reduce bandwidth requirements.
Contact: Edward F. Miller
(216) 433-3479

**Vacuum Electronics —** Research on vacuum electronics to improve the efficiency, operating life, and communications qualities of electron beam devices for use in space communications. Specific technologies of interest are electron emission (including thermionic, field and secondary emission), electron beam formation and control, electromagnetic/electrodynamic computer modeling and design, application of microfabrication to vacuum devices, and microwave power modules. State-of-the-art experimental and computational facilities are available.
Contact: James A. Dayton, Jr.
(216) 433-3515

**MMIC Technology —** Research to establish the technical feasibility of advanced solid-state devices and circuits. Research is focused on technologies in support of monolithic microwave/millimeter wave integrated circuits for transmitter and receiver modules. Areas of interest include transmission media, circuit analysis, device modeling, materials growth, and characterization. Materials of interest include III-V semiconductor heterostructures (GaAs, InGaAs, InP, AlGaAs). Also under investigation is the application of high temperature superconductors to microwave and millimeter wave electronics, principally in the areas of antennas and receivers.
Contact: Regis F. Leonard
(216) 433-3500

**Phased Array Antenna Technology —** Research and advanced development of phased arrays for space communication systems for commercial applications and NASA missions. Emphasis is on development of K/Ka-band arrays/array feeds in which distributed monolithic microwave integrated circuit (MMIC) devices provide amplitude and phase weighting. Principal thrusts are on MMIC insertion technologies, including MMIC packaging; printed circuit radiating elements and beam forming/combining networks; and fiber optic links in arrays, as well as on system level integrated circuit development for array applications.
Contact: Charles A. Raquet
(216) 433-3471

**Digital Systems Technology —** Research and advanced digital technology development focused on space communications, bandwidth and power efficient modulation, space based information switching and processing, and ground-based terminals. Specific technologies being developed include: modems; codecs; on-board information switching and processing; FDMA/TDM ground terminals; autonomous network control, fault detection, and diagnostic expert systems, autonomous and adaptive neural networks; and AI for satellite communications network management.
Contact: Joseph L. Harrold
(216) 433-3499

## Space Experiments

**Microgravity Science and Applications —** Basic science experiments designed to capitalize on the microgravity environment of the Space Shuttle in the areas of combustion, metals and alloys, fluid physics and transport phenomena, ceramics and glasses, and electronic materials. Science requirements and conceptual designs are developed using ground-

based 2.2 second and 5 second drop towers and a Learjet aircraft. Activities culminate in the design, fabrication, and flight of space experiments.
Contact: Jack A. Salzman
(216) 433-2868

**In-Space Technology Experiments** — In-space experiments to support advancement of the technology base in the areas of fluid management, energy systems and thermal management, and satellite communications. Areas of investigation include on-orbit fuel storage and transfer, low-gravity fluid behavior and thermal processes, instrumentation, and spacecraft fire safety. While ground-based precursor studies are pursued, emphasis is on the definition and development of cost-effective flight projects that yield results otherwise unobtainable through ground-based experiments or analysis.
Contact: Olga D. Gonzalez-Sanabria
(216) 433-5252

# George C. Marshall Space Flight Center

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***The Marshall Space Flight Center offers opportunities for original work in many areas of the physical sciences, mathematics, and engineering. Theoretical and experimental research is greatly enhanced by the ready access to computers, including the Cray XMP.***

***Before preparing your proposal, prior discussion with a center researcher is recommended. In general, Marshall advisers are interested in collaborative efforts with students and their university advisers and will look favorably on proposals indicating some research time will be spent on-site at the center.***

## Information and Electronic Systems Laboratory

**Electrical Systems —** Activities include development of photovoltaic array systems, battery technology and application, and electrical power system automation. Research is conducted in improved photovoltaic cell design and testing. On-site resources include a semiconductor processing facility and a photovoltaic test laboratory for simulation of on-orbit conditions. Research and application of electrochemistry is utilized to improve space flight batteries with life cycle testing and destructive physical analysis. Artificial intelligence approaches are used to support electrical power system automation.
Contact: R. Bechtel
(205) 544-3294

**Electronics, Sensors, Robotics —** Research, design, and development of activities are conducted on electronic control systems and measurement sensors for the guidance, navigation, and control of space vehicles. Subjects addressed are sensors, transducers, control actuators, reaction wheels, and pointing systems. Robotics and teloperation are studied. The Flight Robotics Laboratory is used for concept study, development, and testing of sytems used for the rendezvous and docking of spacecraft in orbit. On-orbit servicing and man-machine interface studies are conducted.
Contact: E. C. Smith
(205) 544-3506

**Optical Systems —** Opportunities exist for research, development, and application of technology in the following areas: coherent lidar systems (both gas and solid-state technologies), target and detector calibration, transmitter evaluation, signal processing atmospheric propagation and system modeling; video/film camera systems, including imaging systems development, fiber optics, video compression, radiometry, film, camera and video system evaluation; and optical design, fabrication and testing including straylight analysis and testing, performance analysis, coating metrology, precision engineering and binary optics.
Contact: J. Bilbro
(205) 544-3467

**Audio Systems —** Design, development, and evaluation of flight audio communications systems are performed in support of ongoing and future programs. Specific areas of interest include digital signal processing and encoding techniques, voice synthesis and recognition, and the effect of background noise on intelligibility.
Contact: P. Clark
(205) 544-3661

**Communications Systems —** Test facilities are available to pursue research and development of antenna components and systems. These facilities include a fully automated kilometer pattern test range and a shielded anechoic chamber with 3.7-meter diameter quiet zone and supporting test equipment operating up to 60 GHz. Other areas of interest include high-power, solid-state transmitters and spread spectrum receivers.
Contact: D. Harris
(205) 544-3676

**Software and Data Management —** An area of high interest is the automatic generation of digital computer code from structured requirements. An area of particular interest is definition of a set of integrated computer aided support tools for software development from requirements phase through validation for embedded computer systems. Another target area of research and development is Artificial Intelligence techniques and tools to aid in fault

diagnosis, load management, and scheduling for flight systems and subsystems.
Contact: D. Aichele
(205) 544-3722

**Materials and Proceses Laboratory** — Major technology and research efforts are underway in physics and chemistry of metallic and nonmetallic materials in critical environments (cryogenic to high temperature) and new and improved techniques for developing spacecraft hardware. Comprehensive research and development activities are pursued in qualification and testing of materials and processes.

**Space Environmental Effects on Materials** — Evaluation of material is accomplished in simulated space environments involving vacuum, temperature, electron/proton, and UV irradiation, atomic oxygen, and micrometeoroid impact. The effects of outgassing products of materials on weight loss, strength loss, surface properties, and re-deposition and condensation on other items are being studied. Studies involving lubrication and surface physics of bearings in space and in rocket propulsion components are also being conducted. Research and development in new nondestructive evaluation (NDE) methods/processes and instrumentation are encouraged.
Contact: A. Whitaker
(205) 544-2510

**Metallic Materials** — Development of alloys for special applications in propulsion systems is ongoing. The effect of high-pressure, high temperature hydrogen on metals is an area of special emphasis. Research in microstructural analysis methods is being accomplished in support of failure analysis and fracture mechanics programs. Methods are being developed for quantitatively determining the state of corrosion, stress corrosion, and hydrogen embrittlement of alloys.
Contact: P. Munafo
(205) 544-2566

**Nonmetallic Materials Research** — Opportunities exist to develop and modify polymers for adhesives, elastomers, insulators, composite matrices, and molding and extrusion compounds for use in spacecraft hardware and in special environments. Organic composities such as carbon-carbon and carbon-resin are being developed for structural applications to reduce mass or for high temperture applications such as rocket engine nozzles and leading edges. Research and development activities are being conducted to evaluate new analytical chemistry techniques or instrumental methods to assist in determining materials' properties under various temperatures, pressures, and environments. Microbiological research is being performed to study the long term effects of the ecology on materials in closed space environments. In addition, ceramics and glasses with special optical properties for use in spacecraft are being studied.
Contact: C. McIntosh
(205) 544-2620

**Process Engineering Research** — Major research and technology efforts are underway in composite material fabrication, testing, and qualification for flight hardware application. Composite methodologies include automated filament winding and tape laying, pultrusion, tape wrapping, fiber placement, and hand lay-up. Additional opportunities exist relative to the development, application, and evaluation of cryogenic and high temperature thermal protection materials used in association with both liquid and solid propellant rocket motors. Several ongoing efforts exist relative to advanced welding methods, intelligent processing, robotics, and the development of sensors for chemical and welding process controls. Opportunities also exist in the development of environmentally acceptable cleaning materials for use in the fabrication of components for launch vehicles.
Contact: M. H. Sharpe
(205) 544-2714

**Propulsion Laboratory** — Activities are directed toward the research, technology, and flight hardware development of propulsion systems for launch and space vehicles and support equipment. Areas of activity include liquid and solid propulsion and control systems for the Space Shuttle, space propulsion and support systems, advanced chemical and nuclear propulsion systems for future launch and space vehicles, and flight experiment and space station mechanisms.

**Systems Division** — Research and development is ongoing in liquid rocket engines, solid motors, propulsion systems, and reaction control sytems. Activities include predicting, analyzing, and evaluating propulsion system and launch vehicle performance, and establishing test, integration, and verification requirements for flight and test bed propulsion systems. There is continuing interest in solid and liquid propellant combustion, performance prediction, engine risk management, launch and space vehicle propellant and pressurization systems, hybrid boosters, and advanced engine health monitoring subsystems. Special emphasis areas are zero- and low-gravity propellant systems and combustion.
Contact: J. Redus
(205) 544-7051

G. Lyles
(205) 544-2251

**Component Development Division** — Activities involve research and development for mechanical subsystems such as propulsion feedlines, turbo-machinery, combustion devices,

thrust vector control, auxiliary propulsion, valves, actuators, controls, mechanisms, and environmental control and life support hardware. Another area of interest is establishing test, integration, and verification requirements for mechanical elements.
Contact: C. S. Cornelius
(205) 544-7130

**Combustion Devices and Turbomachinery** — Investigation of combustion stability, performance, and heat transfer of large rocket engine thrust chambers are of special interest. Techniques for understanding the failure and wear modes and improving the life of propellant cooled antifriction bearings are needed for reusable rocket engines.
Contact: G. Young
(205) 544-7070

**Control Mechanisms** — Present activities include design and testing advanced electromechanical mechanisms applicable to the next generation of NASA launch vehicles. Opportunities exist in control system modeling and analysis, component and subsystem design, and development testing of prototype propellant delivery components and subsystems applicable to both liquid and solid fueled propulsion systems. Primary emphasis is on high output force activators applicable to engine thrust vector control, including electrical power sources such as turbine driven alternators, storage batteries, or other means of providing electrical power for advanced electromechanical control mechanisms.
Contact: J. Harbison
(205) 544-7143

**Docking/Berthing Sensors** — The proposed task calls for the development of an automated delivery system required for practical implementation of panoramic imaging techniques. The proposed system relies on a unique panoramic lens that produces a flat annular image of the entire 360-degree surround of its optical axis. The task is geared towards berthing and docking operations for a space station and capture of satellites.
Contact: T. Bechtel
(205) 544-7160

**Test Division** — Activities include experimental research and development testing of propulsion systems, subsystems, and components for space systems hardware. Current specific areas of interest relate to automated test control systems. A continuing interest exists for new and advanced instrumentation techniques.
Contact: R. L. Thompson
(205) 544-1247

R. M. Lynn
(205) 544-1169

## Space Science Laboratory

**Tropospheric Wind Profiling** — Wind profiles to heights of 18 km and estimates of wind variability are critical inputs for launch vehicle design and actual launch decisions. To optimize vehicle performance, high temporal and spatial resolution is required for wind profile measurements. Currently, NASA uses Jimsphere balloons and a 50-Mhz radar wind profiler for wind profile measurements. Measured profiles are analyzed to produce a representative climatology and to study relationships between wind magnitudes, vertical shears, and spatial and temporal wind variability.
Contact: Steve Smith
(205) 544-5971

**Stratospheric and Mesospheric Studies** — Middle atmospheric (50-100 km) density must be accurately described to permit safe re-entry and space maneuvers. Satellite, rocket, balloon, lidar, radar and nightglow measurements are being assembled into a self-consistent dynamical atmospheric model. All scales of motion from seasonal to planetary waves to tides to gravity waves are important to vehicle and trajectory designers. Theoretical and empirical research efforts are examining such atmospheric waves and their interactions.
Contact: Steve Smith
(205) 544-5971

**Model Studies of Storm Electrical Processes** — This research estimates the Maxwell current between discharges and the Wilson conduction current. The Maxwell current was found to vary linearly with total flash rate. The Wilson conduction current tended to level off with increasing flash rate. Recent efforts to gain a better understanding by modeling U-2 observations provided extremely encouraging results. The modeling should now be extended to study more quantitatively the relationship between lightning rates and characteristics (e.g., charge transfers, percentage of cloud-to-ground, etc.) and the resultant currents.
Contact: Richard Blakeslee
(205) 544-1652

**Cloud Scattering of Lightning Discharges** — This task is to model the radiation viewed from space resulting from lightning discharges within clouds. The solution is given in terms of scattering amplitudes that take into account the propagation parameters of air, water, and ice. Reciprocity relations for the scattering cross sections correspond to an arbitrary direction of the incident wave. The interest of this work is in determining the relationship between cloud physics parameters, lightning discharges, and the remotely sensed signal to be viewed from space.
Contact: Hugh Christian
(205) 544-1649

**Climate Modeling with the CMI —** This research effort is geared toward understanding the sensitivity of the climate model to surface boundary forcing, i.e., sea surface temperature, albedo and soil moisture anomalies. Several experiments with different forcing will be compared to the control run climate. Extensive CRAY usage (approximately 100 CPU hours) will be required. Comparison of results to observed atmospheric behavior will be carried out eventually using MSU, OLS, and AVHRR satellite data.
Contact: Dan Fitzgarrald
(205) 544-1651

**Physical Climate Analysis —** Observational, numerical modeling and analytical approaches are used to study the Earth's physical climate system. Diagnostic analysis of space-based observations are used to understand and validate models of global hydrologic cycle. Numerical models ranging in scope from the atmospheric general circulation codes to mesoscale and cloud models are used to test models of the water cycle and its role in climate. Simulations of remote sensors are used to understand how space-based observations can best study the Earth as a system.
Contact: F. Robertson
(205) 544-1655

**Geophysical Fluid Dynamics and Modeling —** The fundamental fluid dynamics of the Earth are not well understood. Research is underway to develop and use models to understand the system, including laboratory models, numerical models, and more detailed numerical models of the atmosphere and its interaction with the underlying surface. The results from these modeling efforts will be used to guide the development of more sophisticated models of the geophysical system, as well as the development of sensors.
Contact: T. L. Miller
(205) 544-1641

**Space Vehicle Environments —** Research activities are underway to improve knowledge of the natural space environment to support engineering of advanced NASA missions. Emphasis is on study of the density, composition, and temporal variation of the Earth's thermosphere and mesosphere, and the Martian atmosphere. The objective is to improve knowledge and environmental models which impact the design of re-boost, guidance, navigation and control systems for orbiting vehicles, or which influence on-orbit safety factors.
Contact: Jeffrey Anderson
(205) 544-1661

**Surface Properties/Atmospheric Boundaries Interactions —** Research activities undertaken will emphasize interactions between unconsolidated sediments on the surface and atmospheric processes in the boundary layer on a local and regional basis and all time scales. Mass and energy transport phenomena will be studied. Comparison with hydrologic models will be made for the conditions studied. The results of such comparisons will be verified by appropriate sensors from laboratory experimental investigations, field ground-based stations, and remote sensors.
Contact: N. Costes
(205) 544-1637

**Atmosphere/Land Surface Interface —** Earth's surface geophysical properties, and their linkages to the atmosphere and hydrologic cycles, are being modeled using remotely sensed data. Measurements from satellite and aircraft sensors are utilized to study spatial and spectral resolution and temporal variability effects on the determination of land surface temperatures and energy fluxes and vegetation indices. The influence of vegetation type and structure on these properties are examined from several ecosystem types.
Contact: J. Luvall
(205) 544-2809

**Magnetospheric and Plasma Physics —** Research is centered around the study of plasma processes in the Earth's magnetosphere. Particular emphasis is placed on the characteristics of the low-energy thermal plasma of the plasmasphere and ionosphere, medium-energy plasma responsible for auroral phenomena, interactions between these plasma populations, and resulting effects on the upper atmosphere. Activities include design, development, and calibration of flight instrumentation and analysis and interpretation of resulting data.
Contact: T. Moore
(205) 544-7633

**Aeronomy —** Research in this area is aimed at understanding the Earth's middle and upper atmosphere. Experimental programs are underway featuring remote sensing in the vacuum ultraviolet, visible and near-infrared, including instrumentation on Shuttle, satellites, stratospheric balloons, and ground sites. An important aspect is development of advanced optical and focal plane detection systems for exploring the physics and chemistry of this region from space platforms.
Contact: M. Torr
(205) 544-7676

**Solar Physics —** The influence of the magnetic field on the development and evolution of solar atmospheric structure is studied. The primary data are vector magnetograms obtained at Marshall's Solar Observatory. These observations are complemented by theoretical studies to characterize the nonpotential properties of these fields. This includes the development of MHD (magnetohydrodynamic) codes designed to simulate both coronal and large scale interplanetary dynamics. Instrument development programs in optical polarimetry, grazing, and

normal incidence X-ray optics, and imaging detectors are being pursued.
Contact: J. Davis
(205) 544-7600

**X-ray Astronomy** — Theoretical and experimental research is conducted in the fields of X-ray astronomy and high-energy astrophysics. Specialities include study of neutron stars, active galactic nuclei, and imaging X-ray detectors operating from 1/4 keV to 100 keV. Opportunities include participating in balloon flights of these detectors, theoretical studies of physical processes near compact objects, and analysis of data from the Einstein (HEA02) and EXOSAT satellites.
Contact: M. Weisskopf
(205) 544-7740

**Gamma Ray Astronomy** — Gamma ray astronomy is performed with balloon-borne and orbiting instruments designed and developed at MSFC. The research includes experiments covering the 30 keV to 10 MeV region to study gamma ray bursts and other transient sources, pulsars, and to study the variability and spectra of known sources. Present activities include analysis of data from the Burst and Transient Source Experiment on the Gamma Ray Observatory, and the development of new balloon-borne instruments. A study of the gamma ray background in the atmosphere and on spacecraft is in progress with calculations and with measurements on Spacelab, LDEF, and GRD.
Contact: G. Fishman
(205) 544-7691

**Cosmic Ray Research** — Cosmic ray research at MSFC emphasizes the study of the chemical composition and energy spectra of cosmic ray nuclei above 105 GeV. Study of the interactions of heavy cosmic ray nuclei is also carried out to determine the behavior of nucleus interactions and to search for evidence of new states of nuclear matter. The research is carried out principally with emulsion chambers, and with electronic counters, exposed on balloons at about 40-kilometers for up to two weeks. Research includes laboratory work data analysis, particle cascade calculations, and correlative accelerator experiments.
Contact: T. Parnell
(205) 544-7690

**Infrared Astronomy** — Astronomical research is carried out in close coordination with the development of IR sensors. The sensors, which span the spectral region between one and 30 micrometers, are used at major telescopes to produce unique images of comets and regions of star formation in our own and other galaxies. These data provide clues to cometary structure, origin, and long-term evolution.
Contact: C. Telesco
(205) 544-7723

**Cryogenic Physics** — Experimental and theoretical research is conducted on cooled sensors for advanced space science experiments and cooling systems to support the sensors. Stored cryogens and their containment systems are developed, as well as active refrigeration systems extending both to sub-Kelvin temperatures needed by infrared bolometers and conventional superconducting electronic devices, and to higher operating temperatures required by high critical temperature superconducting electronic devices. Sensor research includes conventional and superconducting infrared detectors and arrays for cometary and galactic astronomical observations, and superconducting devices such as cooled gyroscopes, electronic devices, and sensitive accelerometers, in support of gravitational physics program. Well-equipped laboratories exist to support research on improved superconducting materials and sensors.
Contact: E. Urban
(205) 544-7721

**Low-Gravity Science** — Theoretical and experimental research is conducted on the effects of gravity on the crystal growth or solidification of materials including semiconductors, metals, alloys, proteins, polymers, model systems, etc. Both the preparation and the characterization of materials are important. The areas of research include solid-state physics, surface physics, solidification phenomena, separation techniques, fluid modeling, analysis of crystal growth, and characterization techniques such as optical, X-ray, and electron microscopy. In addition to well equipped laboratories for these activities, the division operates a drop tube and drop tower each 100-meter high.
Contact: F. Szofran
(205) 544-7777

**Biophysics** — An opportunity exists to conduct research in the separation and purification of biological cells and proteins to develop a basic understanding of the separation phenomenon. The proposed research should include analysis of the fundamental behavior of a separation process by theoretical and/or experimental methods. A second activity involves laboratory and space experiments in protein crystal growth. High quality single crystals are required to obtain the three-dimensional structure of the proteins, and Shuttle space experiments confirm the advantages of the microgravity environment. Projects include experiments to define improved crystallization conditions and the analysis of crystals by X-ray diffraction.
Contact: R. Snyder
(205) 544-7805

## Structures and Dynamics Laboratory

**Pointing Control Systems** — Tasks include pointing systems with performance of one milli-arcsecond, ability to actively control structures with structural modes below the control frequency, use of fiducial light systems and unobtrusive sensors/effectors to stabilize large space structures, development of the theory of many control systems working on the same flexible structure, modeling and control of flexible multibodies with configuration changes, and momentum exchange control of very large objects.
Contact: H. Waites
(205) 544-1441

**Controls for Vehicles** — Automatic or remote piloted precision recovery of objects from Earth orbit, control system development for dynamic objects connected by low-tension tethers, control of aero-assisted tugs, and remote piloted controls for docking with uncooperative, dynamic objects are being investigated.
Contact: N. D. Hendix
(205) 544-1451

**Liquid Propulsion Dynamic Analysis** — Tasks include dynamic analysis, determination of damping methods, analysis of bearings, and dynamic balancing of high speed turbomachinery. Topics of interest in control include rapid recognition of engine failure, detecting incipient failure, automatic reconfiguration of control components, and more accurate means to control propellant mixture ratio.
Contact: P. Vallely
(205) 544-1440

**Structural Dynamics** — Activities of interest are aerostructural modeling, vibration analysis, and load predictions using simulation of all environments, including propulsion, control, aerodynamics, and atmosphere. Probabilistic, as well as deterministic, approaches are used on the CRAY to simulate flight and obtain loads data. Enhanced dynamic analysis techniques are pursued.
Contact: W. Holland
(205) 544-1495

**Structural Assessment: Structural Analysis** — Opportunities exist for research in strength, stability, fatigue, and fracture mechanics analyses. Extensive use is made of computationally intensive methods such as finite and boundary element analyses. Practical enhancement methods are sought such as solution adaptive finite element modeling techniques. Technology improvement in analysis and computational methods which lead to development of practical engineering tools are encouraged. The CRAY computer is available for analytical analysis in conjunction with work stations.
Contact: C. J. Bianca
(205) 544-7182

**Vibroacoustics** — Mechanically and acoustically induced random vibration design and test criteria and response loads analytically derived using advanced computer techniques. Vibration, acoustic, and transient data from engine static firing and Space Shuttle flights are analyzed and categorized. Research opportunities include improved vibroacoustic environment prediction methods and high frequency vibration data reduction techniques.
Contact: H. J. Bandgren
(205) 544-5714

**Structural Design** — As part of the agency's efforts on in-space assembly and construction, design and testing of temporary and permanent joints for heavily loaded structures is ongoing. The goal is to design joints which can be assembled via fastening or welding with minimum or no EVA (extra-vehicular activity). Research is also needed in the area of smart structures for the design of space and/or launch vehicle structures (i.e., elimination of shear center through the use of composite materials).
Contact: P. Rodriguez
(205) 544-7006

**Thermal Analysis: Liquid Propulsion Systems** — Opportunities for research exist in thermal analysis of liquid propulsion system components, including integrated thermal/structural analysis of turbine blades and fluid/thermal modeling of bearing systems in high-pressure turbomachinery. Analytical results may be correlated to ground test data.
Contact: J. Owen
(205) 544-7213

**Thermal Analysis: Solid Rocket Motor** — Opportunities are available for research in thermal modeling and analysis of solid rocket motor thermal protection systems. Specific areas include the modeling of ablation processes involving a variety of material surfaces and the determination of heat transfer coefficients in radiative, erosive, and chemically reactive environments.
Contact: K. McCoy
(205) 544-7211

**Thermal/Environmental Computational Analysis** — Research opportunities are available in advanced thermal modeling and analysis techniques based on state-of-the-art graphics systems and software. Research is needed in methods of 3-D graphic modeling of thermal systems which are compatible with computational fluid dynamics and stress modeling.
Contact: J. Sims
(205) 544-7212

**Hypervelocity Impact Design and Analysis** — Research opportunities are available in the design, analysis, and testing of advanced hypervelocity impact shields. Due to the increased space debris, more efficient and

lightweight shields are needed for all future long-term space endeavors. Specific areas include ballistic limit predictions, impact and penetration effects, innovative shield designs for minimum EVA (extra vehicular activity), quick deployment/retraction shields, composite material shield design, exotic shields, and damage prediction.
Contact: J. Robinson
(205) 544-7013

**Computational Fluid Dynamics** — Opportunities to develop and apply state-of-the-art computational fluid dynamic (CFD) methods to solve three-dimensional highly turbulent flows for compressible and incompressible fluid states; and to provide benchmark CFD comparisons to establish code quality for subsequent application. Research is needed to assess significant aspects of the computational algorithms, grid generation, numerical problem formulation, code efficiency, convergence rate, stability, etc.
Contact: P. McConnaughey
(205) 544-1599

## Systems Analysis and Integration Laboratory

**Engineering Graphics Workstation** — High-performance computer workstations are utilized to visualize and study spacecraft design and configuration. Development of innovative concepts focuses on utilizing workstations to perform trade studies and analyses to achieve optimal configuration and assembly sequences for projects such as the Space Station *Freedom*.
Contact: R. Harrison
(205) 544-2455

**Configuration Management** — Configuration management is an essential component of any successful engineering activity. Marshall projects tend to be both large and complex, requiring the efforts of teams of both NASA and contractor engineers. The level of control required by manned space flight makes configuration management a critical activity. Automated tools and improved methods are continually sought.
Contact: N. Foster
(205) 544-2425

**Systems and Components Test and Simulation** — Opportunities exist for the development, qualification, integration, and flight acceptance testing of space vehicles, payloads, and experiments. Neutral buoyancy simulations for training and development of extravehicular activity (EVA) techniques are performed. Thermal vacuum testing is conducted in a variety of chambers with capabilities to lX10-7 torr and temperature ranges from 149C to +204C. Facilities exist to calibrate X-ray payloads and scientific instruments utilizing a 518-meter evacuated guide tube.
Contact: V. Kulpa
(205) 544-1383

R. Stephens
(205) 544-1336

C. Reily
(205) 544-1298

**Crystal Growth in Fluid Field and Particle Dynamic Evaluation** — The Fluid Experiment System (FES) was developed to study low-temperature crystal growth of a triglycine sulfate solution in a low-gravity environment. Incorporated into the FES is a laser/optical system for taking holograms of crystal growth, fluid density, and temperature variations. Tasks include applying holographic and digitized image techniques to evaluating these holograms.
Contact: J. Lindsay
(205) 544-1301

## Missions Operations Laboratory

The Mission Operations Laboratory performs functions contributing to performing science in space, particularly focusing on development of space science operations capabilities. Supporting that development, the Laboratory operates the Huntsville Operations Support Center from which Spacelab science operations are controlled and the Payload Crew Training Complex in which flight crews are trained for on-orbit science activities. The operations control function includes command planning, ground control plans and procedures, requirement development for flight system design, and flight system operation. The data management function includes air-to-ground data flow analysis, requirement development for flight data systems, and intercenter data requirement development. The crew operations support function includes crew procedure development and flight data file development. The mission planning function includes orbit analysis, mission timelining, flight design, and design and development of planning systems including artificial intelligence applications. The ground systems development and operation function includes facilities operation, communications and data systems development, and command and telemetry data base development. The training function includes flight crew training, ground operations personnel training, and development of training systems.
Contact: Brian E. Blair
(205) 544-6796

## Safety and Mission Assurance Office

**Reliability Engineering** — Research and analysis are conducted to gain an understanding of complex physics of

failure mechanisms with the Space Shuttle Main Engine. The use of statistical models, failure mode and effects analysis, and analysis of failure and anomaly reports, as well as applicable generic data, contribute significantly toward the research efforts.

Contact: F. Safie
(205) 544-5278

**Quality Engineering** — Research is performed in areas dealing with software quality control, nondestructive evaluation (radiography, ultrasonic, eddy current), critical process control, use and evaluation of inspection methods, and assessment of critical characteristics in inspection with respect to control of critical items.

Contact: R. Bledsoe
(205) 544-7406

R. Neuschaefer
(205) 544-7382

**Systems Safety Engineering** — Opportunities exist for research in the development and implementation of quantitative and qualitative techniques directed at the identification, evaluation, and control of hazards associated with complex space systems. This includes probabilistic risk assessment, fault tree analysis and applications, interactive hazard information tracking and closure systems, and the identification of conceptual approaches to establishing mission levels and requirements for various types of space missions.

Contact: J. Livingston
(205) 544-0049

# *John C. Stennis Space Center*

*Program Administrator:*
*Dr. Armond T. Joyce*
*Science and Technology Laboratory*
*Stennis Space Center, MS 39529*
*(601) 688-3830*

*NASA's John C. Stennis Space Center, located near Bay St. Louis, MS, has grown into NASA's premier center for testing large rocket propulsion systems for the Space Shuttle and future generations of space vehicles.*

*Stennis Space Center's primary mission is to support the development testing of large propulsion systems for the Space Shuttle, National Launch System, and the Advanced Solid Rocket Motor programs. Static testing is conducted on the same huge concrete and steel towers used from 1966 to 1970 to captive-fire all first and second stages of the Saturn V rocket used in the Apollo manned lunar landing and Skylab programs. Since 1975, the center has been responsible for flight acceptance testing on the Space Shuttle's main engines. The data accumulated from these ground tests, which simulate flight profiles, are analyzed to ensure that engine performance is acceptable and that the required thrust will be delivered in the critical ascent phase of Shuttle flights. No Shuttle main engine can fly before it is fire tested at Stennis Space Center.*

## Technology Development

**Propulsion System Testing Techniques, Simulation, Modeling, and Methodologies —** Research opportunities exist to develop new, innovative techniques to conduct the wide variety of required tests for space systems, stages/vehicles, subsystems, and components. Computational Fluid Dynamics modeling and actual hardware testing might be better coupled or integrated. A flexible, dynamic fluid flow simulation and structural modeling graphic interface research tool is desirable for ground test programs of space propulsion systems. Particular attention is needed to develop materials for LOX service at extreme pressures and to resist hydrogen embrittlement. Technology development is needed for inexpensive ultra-high power pump drivers and prime movers and low operational costs.

Contact: R. Gilbrech
(601) 688-3548

**Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultra High Pressure Fluid Systems** — Over 40 tons of liquefied gases are used annually in the conduct of propulsion system testing at the center. Instrumentation is needed to precisely measure mass flow of cryogens starting at very low flow rates up to very high flow rates at pressures to 15,000 psia. Research, technology, and development opportunities exist in developing instruments to measure fluid properties at cryogenic conditions during ground testing of space propulsion systems. Both intrusive and non-intrusive sensors, but especially non-intrusive sensors, are desired.
Contact: D. Chenevert
(601) 688-3126

**Nondestructive Test and Evaluation** — Advanced instrumentation, methods, and techniques to conduct advanced nondestructive test and evaluation, failure analysis, and purity and cleanliness assessment are desired. The object of nondestructive test and evaluation would range from entire propulsion systems down to the component level. One unique application of nondestructive test and evaluation would be on especially thick walled, high pressure ground test facilities, vessels, and areas not readily accessible to personnel. Research opportunities exist in acoustic emission, ultrasonics, high energy radiography in the nondestructive test and evaluation laboratory.
Contact: W. St. Cyr
(601) 688-1134

**Vehicle Health Management/ Rocket Exhaust Plume Diagnostics** — A large body of UV-visible emission spectrometry experimentation is being conducted during the 80 or more tests each year of the Space Shuttle main engine at Stennis Space

Center. Research opportunities are available to quantify failure and wear mechanisms and related plume code validation. Related topics include combustion stability and mixture ratio and thrust/power level. Vehicle health management/exhaust plume diagnostics experimentation may be readily conducted at the SSC Diagnostics Testbed Facility. Currently, some exploratory studies have been done with emission/absorption spectroscopy, absorption resonance spectroscopy, and laser induced fluorescence.

Contact: G. Meeks
(601) 688-1935

**Spectroscopy Technology for Propulsion System Testing —** Numerous opportunities exist to advance spectroscopy technology for propulsion system testing. Only a relatively small portion of the electromagnetic spectrum has been investigated for use in propulsion system testing and exhaust plume diagnostics/vehicle health management.

Contact: C. Thurman
(601) 688-1023

**Active and Passive Nonintrusive Remote Sensing of Propulsion Test Parameters —** The vast amount of propulsion system test data is collected via single channel, contact, intrusive sensors and instrumentation. Future propulsion system test techniques could employ passive non-intrusive remote sensors and active non-intrusive remote sensing test measurements over wide areas instead of at a few discrete points. Opportunities exist in temperature, pressure, stress, strain, position, vibration, shock, impact, and many other measured test parameters. The use of thermal infrared, ultraviolet, and multi-spectral sensors, imagers, and instruments is possible through the SSC sensor laboratory.

Contact: H. Langeberg
(601) 688-1843

**Environmental Impact from Propulsion System Testing —** The testing of advanced and current propulsion systems may result in impact to the environment. The current plume control technology includes plume deflectors and meteorological prediction. The needed research and technology development would address the impacts, modeling, impact measurement or quantification, and prevention, reduction, or mitigation. The research may also indicate the need for exhaust plume scrubbers or other abatement devices, facilities, equipment, or instrumentation.

Contact: W. St. Cyr
(601) 688-1134

**Ground Test Facilities Technology —** Ground test facilities seldom keep pace with propulsion system development programs partly because the facility is usually designed before the test requirements are known and because test facilities are usually extant and inflexible. An innovative approach to producing flexible, easily adaptable ground test facilities is highly desirable. Research opportunities are available at the Diagnostics Testbed Facility to develop ground test facilities technology.

Contact: D. Chenevert
(601) 688-3126

**LOX/GOX Compatible Materials —** Liquid Oxygen (LOX) and Gaseous Oxygen (GOX) are prime oxidizers for liquid fueled rocket engines and represents a dangerous material to handle. A major need exists for a group of LOX/GOX compatible materials for seats, seals, and solid lubricants for valve and pump components and other uses. Simple, effective, safe techniques to easily and cheaply test or qualify new LOX/GOX compatible materials are desirable.

Contact: W. St. Cyr
(601) 688-1134

**Thermal Protection and Insulation Systems —** The test of liquid rocket systems employ very large flame buckets and diffusers to control, deflect, cool, condition, and reduce the sound level of the plume. Innovative thermal protection tiles, coating, materials, and insulation systems could result in significant savings. Cryogenic lines and vessels typically require expensive vacuum jackets, expansion joints, and devices to maintain the fluids at the required extreme cold and sometimes high pressure conditions. Cheaper, better, or newer thermal protection and insulation systems might do the same tasks and require little or no maintenance.

Contact: W. St. Cyr
(601) 688-1134

**Material and Fluid Science —** In some cases the basic physics of the material, heat transfer, thermal or fluid science are not understood well enough to model the propulsion system test facility to the required level of sophistication. As more advanced systems are developed, fundamental data is needed to properly design the test facilities. Characterization of the collapse factor at pressurant and cryogenic fluid interface, cavitation, and thermal stratification is an area of interest. Research opportunities are available at the 795,000-liter liquid hydrogen barges, High Pressure Gas Facility, Gas and Materials Analysis Laboratory, the Advanced Sensor Development Laboratory, the Diagnostics Testbed Facility, and a planned Cryogenic Conditions Testbed.

Contact: W. St. Cyr
(601) 688-1134

**Propellant and Pressurants Conservation, Recycling, and Energy Conservation —** Large quantities of cryogenic fluids are used to bring propulsion systems and the test facility complexes from ambient temperatures to several hundred

degrees Fahrenheit below zero. This chill down represents a high loss of energy that costs millions of dollars. Research into operations techniques, recovery facilities and equipment, and energy management and conservation could likely improve ground testing and save money and energy.
Contact: D. Chenevert
(601) 688-3126

**Leak Detection, Sensors, Quantification, and Visualization —** Opportunities exist in leak detection technology to determine what is leaking, how much is leaking, the source of the leak, and how to model and visualize the extent of the affected area. Often hydrogen leaks are the topic of concern because of the explosive nature of hydrogen, and the expense of repairing the leak when eventually found. However, other hazardous and nonhazardous fluid leaks are also of concern. Leaks usually occur in accessible compartments and locations and may occur in inert gas backgrounds as well as in atmospheres where oxygen is present. Leak pinpointing techniques that may not employ instrumentation are of interest.
Contact: G. Meeks
(601) 688-1935

**Advanced Propulsion Systems Testing —** Innovative techniques will be required to test propulsion systems such as advanced chemical engines, single-stage-to-orbit rocket plane components, nuclear thermal and nuclear electric rockets, and hybrid rockets. With a shrinking budget and longer lead times to develop new propulsion systems, new approaches must be developed to test future propulsion systems. The solution may be some combination of computational-analytical techniques, advanced sensors and instrumentation, and predicative methodologies.
Contact: D. Chenevert
(601) 688-3126

## Information Systems

**Computational Modeling and Simulation —** The Information Systems Division has research in progress to determine and assess the categories of modeling software tools that can support science and engineering users in developing, using, and exercising large scale models in supercomputing applications, with specific emphasis on applicability to propulsion testing requirements. The research will include a classification of the various models that can support propulsion tests and further justify how these models would apply to specific propulsion test tasks and activities. The research will also define and document a detailed procedure and process for using a supercomputer at SSC.
Contact: K. Sharp
(601) 688-3586

**Artificial Intelligence (AI) Capability for Intelligent Processing of Remotely Sensed and Propulsion Test Data —** Artificial Intelligence techniques and concepts are being investigated to determine which can be used to collect, organize, and retrieve the vast amounts of data produced by NASA missions. This research will focus on investigating the use of AI expert system technology in the classification of remotely sensed spatial data and extraction of information from propulsion test data. This effort will result in a survey and evaluation of expert system shells, a survey and evaluation of AI tool boxes for uncovering relationships in data, and porting a satellite image classification methodology written in the AI language PROLOG and C onto an IBM computer.
Contact: K. Sharp
(601) 688-3586

B. Spiering
(601) 688-3588

**Use of Visualization Technologies for SSC Data Analysis —** This research will consist of reviewing current visualization software packages (i.e., AVS) and identifying the feasibility of using these for developing interface and file format standards for use across SSC programs in order to share resources, data, techniques, and technologies. Various SSC programs/activities, such as CTF, ASRM, NLS/ALS, center archival, and propulsion testing, require a "visualization" function for data analysis and display. A feasibility demonstration will be developed using an actual application, thus allowing the visualization technology to be used across multiple SSC programs.
Contact: K. Sharp
(601) 688-3586

**Application of Parallel Computing to Data Analysis —** The purpose of this research is to obtain a firm understanding of how this potentially radical technology can be applied to several NASA applications. This effort will result in an examination of the commercially available options, the nature of the algorithms currently employed, and the existing facilities. Based on the results, a proto-type or demonstration system will be built.
Contact: K. Sharp
(601) 688-3586

**Visual Data Analysis —** Opportunities exist for the development and enhancement of software tools to support the visualization of propulsion test data. Incorporate the use of artificial intelligence to develop automated and semi-automated methods of data interpretation. Incorporate modeling techniques to allow the investigator to explore a variety of "what if" situations.
Contact: K. Sharp
(601) 688-3586

**Propulsion Test Data Acquisition Systems —** Investigations into the

integration of real-time propulsion test systems are needed. Specifically, how can large amounts of data from sensor channels and controls systems be optimally managed? Research is needed into optimum data channel bandwidth, the appropriate separation of control and data systems, and how the data and control systems can exchange data given the separation.
Contact: K. Sharp
(601) 688-3586

## Commercialization

**Earth Observation Technology —** Promote the commercial use of space related to Earth observations technology by providing an interface between industry, NASA, and other Federal agencies; reduce the technical and financial risk of the private sector during new Earth observation venture development; develop and/or improve advanced, remote sensing and Geographic Information System-related technologies and apply and transfer such technologies to industry, government, and universities; and optimize or customize commercially available software for project-specific applications.
Contact: R. Barlow
(601) 688-2042

# *Section III —*

# *Underrepresented Minority Focus Component*

# *Under-represented Minority Focus Component*

*Summary and Objectives*

*For more than 30 years NASA has had significant involvement with numerous universities across the nation. Talented faculty, graduate students, and postgraduates have carried out research for us. While we are pleased with these valuable relationships, we are concerned that relatively few members of underrepresented minority groups are participating in this research. Students selected for the program will collaborate with faculty advisors and with NASA technical officers at Headquarters or at one of the NASA field centers. Students are encouraged to contact the appropriate facility technical advisor to coordinate research activities.*

*The program offers:*

- *up to $22,000 per year of support for a total of three years;*
- *first hand exposure to NASA research;*
- *the opportunity to work at national laboratories with unique facilities;*
- *the chance to interact with the nation's top aerospace engineers and scientists.*

*Awards are initially made for a one-year period and may be renewed annually.*

**Eligibility** — Because Blacks, Hispanics, American Indians, Pacific Islanders (having origins in any of the original peoples of Hawaii; the U.S. Pacific Territories of Guam, American Samoa, and the Northern Marianas; the U.S. Trust Territory of Palau; the Islands of Micronesia and Melanesia; and the Philippines), and individuals with a disability that limits a major life activity have been underrepresented in science and engineering, they are the focus of this special effort. Applicants must be:

- enrolled in a full-time graduate program at an accredited U.S. college or university;
- studying engineering, physics, mathematics, computer science, biology, aeronautics, space sciences, life sciences, or another discipline of interest to NASA;
- highly motivated to pursue their plans of study in NASA related research;
- U.S. citizens.

Students may enter the program at any time during their graduate work or may apply prior to receiving their baccalaureate degrees. An application must be sponsored by the student's graduate department chair or faculty advisor. Those selected will usually receive support until they obtain an advanced degree, a maximum of three years in most cases. Individuals accepting this award may not concurrently hold another Federal fellowship or traineeship. Students who apply to this program are also eligible for the Graduate Student Researchers Program.

**Selection of Proposals —** Graduate students will be selected on the basis of their academic qualifications; the quality of their plan of study or proposed research and its relevance to NASA's research interests and needs; if applicable, the student's utilization of research facilities at the NASA centers; and to maintain appropriate balance between male and female applicants.

**Multiple Submissions —** When submitting to more than one NASA facility or to both the Underrepresented Minority Focus (UMF) Program and the Graduate Student Researchers Program (GSRP), separate original application forms and all required information, including the number of copies necessary to evaluate the proposal, must accompany each submission.

**Application Procedure —** All applicants must submit one original and nine (9) copies of all materials by February 1 of each year to the appropriate NASA facility, addressed to the attention of the Underrepresented Minority Focus Program Administrator listed on the following page.

For detailed instructions on administrative procedures and proposal format for the Underrpresented Minority Focus Component see pages 14-19.

# Underrepresented Minority Focus Program Administrators

Mr. John T. Lynch
GSRP/UMF Program Manager
**NASA Headquarters**
Code FEH
Washington, DC 20546
Phone (202) 358-1531
FAX (202) 358-3048

Ms. Deborah Russell
Program Manager, Scholarships and Fellowships
Code EU
**NASA Headquarters**
Washington, DC 20546
Phone (202) 358-0935
FAX (202) 358-3061

Ms. Meredith Moore
University Affairs Officer
Mail Stop 241-3
**Ames Research Center**
National Aeronautics and Space Administration
Moffett Field, CA 94035
Phone (415) 604-5624
FAX (415) 604-3622

Ms. Meredith Moore
University Affairs Officer
Mail Stop 241-3
**Hugh L. Dryden Flight Research Facility**
Edwards AFB, CA 93523
(Program administered by Ames Research Center - see above)

Dr. Gerald Soffen
Director, University Programs
Code 160
**Goddard Space Flight Center**
National Aeronautics and Space Administration
Greenbelt, MD 20771
Phone (301) 286-9690
FAX (301) 286-1610

Dr. Harry I. Ashkenas
University Affairs Officer
Mail Stop 183-900
**Jet Propulsion Laboratory**
National Aeronautics and Space Administration
4800 Oak Grove Drive
Pasadena, CA 91109
Phone (818) 354-8251
*For inquiries call:*
Ms. Carol S. Hix
Assistant University Affairs Officer
Mail Stop 183-900
Phone (818) 354-3274
FAX (818) 393-4977

Dr. Stanley H. Goldstein
Director, University Programs
Mail Code AHU
**Lyndon B. Johnson Space Center**
National Aeronautics and Space Administration
Houston, TX 77058
Phone (713) 483-4724
FAX (713) 483-2543

Mr. Bill J. Martin
Manager, University Liaison
Mail Stop PT-PAS
**John F. Kennedy Space Center**
National Aeronautics and Space Administration
Kennedy Space Center, FL 32899
Phone (407) 867-2512
FAX (407) 867-2050

Mr. Edwin J. Prior
Acting University Affairs Officer
Mail Stop 105-A
**Langley Research Center**
National Aeronautics and Space Administration
Hampton, VA 23681-0001
Phone (804) 864-4000
FAX (804) 864-6521

Dr. Francis J. Montegani
Chief, Office of University Affairs
Mail Stop 3-7
**Lewis Research Center**
National Aeronautics and Space Administration
21000 Brookpark Road
Cleveland, OH 44135
Phone (216) 433-2956
FAX (216) 433-3687

Dr. Frank Six
University Affairs Officer
Mail Stop DS01
**Marshall Space Flight Center**
National Aeronautics and Space Administration
MSFC, AL 35812
Phone (205) 544-0997
FAX (205) 544-5893

Dr. Armond Joyce
University Affairs Officer
Science and Technology Branch
**John C. Stennis Space Center**
National Aeronautics and Space Administration
Stennis Space Center, MS 39529
Phone (601) 688-3830
FAX (601) 688-1925

# PROPOSALS DUE FEBRUARY 1

*NASA Graduate Student Researchers Program Proposal Cover Sheet • Underrepresented Minority Focus*

## I. Student Information

Name: (Mr/Ms)

Last First MI

Birth Date: _____

Birthplace: _____

Home Address: _____

_____

Home Phone: _____

Target Degree: __ MS __ MS/PhD (Joint) __ PhD

Discipline: _____

Department:

Campus Address: _____

Mail Code: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____ Fax No.: _____

E-Mail: _____

Undergraduate GPA : _____ Out Of _____

Discipline: _____

Graduate GPA (If Applicable): _____ Out Of _____

Discipline: _____

## II. Faculty Advisor Information

Name: _____

Department: _____

Campus Address: _____

Mail Code: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

Fax Number: _____

E-Mail: _____

*Signature:* _____ *Date:* _____

## III. Official Responsible for Committing Institution

Name: _____

Title: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

*Signature:* _____ *Date:* _____

*I certify that I am a citizen of the United States and I am or will be a full-time graduate student during the period covered by the attached proposal, and that I am a member of one of the following underrepresented minorities:*

- ☐ Black Male
- ☐ Black Female
- ☐ Hispanic Male
- ☐ Hispanic Female
- ☐ American Indian Male
- ☐ American Indian Female
- ☐ Pacific Islander Male*
- ☐ Pacific Islander Female*
- ☐ Male with Disability **
- ☐ Female with Disability **

*Signature:* _____ *Date:* _____

* *A person having origins in any of the original peoples of Hawaii; the U.S. Pacific Territories of Guam, American Samoa, and the Northern Marianas; the U.S. Trust Territory of Paulau; the Islands of Micronesia and Melanesia; and the Phillipines*

** *A disability that limits a major life activity*

## IV. Proposal Information

Type of Proposal:

☐ (1) New ☐ (2) Second Year ☐ (3) Third Year *If Renewal, Designate Grant No.:* **NGT-** _____

Proposed Start or Renewal Date: _____ Expected Completion Date: _____

Proposal Title: _____

_____

## V. Submission Information

☐ Headquarters ☐ NASA Centers

Other Facilities to which this proposal is being submitted:

_____

_____

_____

- __ Ames/Dryden (ARC/DFRF)
- __ Goddard (GSFC)
- __ Johnson (JSC)
- __ Jet Propulsion Lab (JPL)
- __ Kennedy (KSC)
- __ Langley (LaRC)
- __ Lewis (LeRC)
- __ Marshall (MSFC)
- __ Stennis (SSC)

Center Technical Advisor:

_____

## VI. Proposal Checklist

- ☐ Original and 9 Copies
- ☐ Original Transcripts
- ☐ Signed Advisor Evaluation
- ☐ Budget Form
- ☐ University Certifications
  - Suspension and Debarment
  - Drug Free Workplace

## *VII. NASA Use Only*

- ☐ Org/Cpys
- ☐ OT
- ☐ SAE
- ☐ BdgtFrm
- ☐ UCert
- ☐ Returned Proposal

## NASA Graduate Student Researchers Program • Underrepresented Minority Focus
## Budget Information

**I. Student Stipend** (Maximum of $16,000) $_____

**II. Student Allowance** (Itemize if necessary)

Student Allowance Total $_____
(Maximum of $3,000)

**III. University Allowance** (Itemize if necessary)

University Allowance Total $_____
(Maximum of $3,000)

***Total Requested*** $_____
(Maximum of $22,000)

# *Section IV —*

# *NASA Graduate Fellowships in Global Change Research*

# *NASA Graduate Student Fellowships In Global Change Research*

***Introduction — NASA announces graduate student training fellowships for persons pursuing a Ph.D. degree in aspects of global change research. These fellowships will be available for the 1993/94 and 1994/95 academic years. The purpose is to ensure a continued supply of high-quality scientists to support rapid growth in the study of Earth as a system. A total of 150 fellowships have been awarded since the inception of the program in 1990. Up to 50 new fellowships will be awarded each year, subject to availability of funds.***

**Areas of Support** — Applications will be considered for research on climate and hydrologic systems (including tropical precipitation), ecological systems and dynamics, biogeochemical dynamics, solid Earth processes, human interactions, solar influences, and data and information systems. Atmospheric chemistry and physics, ocean biology and physics, ecosystem dynamics, hydrology, cryospheric processes, geology, and geophysics are all acceptable areas of research, provided that the specific research topic is relevant to NASA's global change research efforts including the Earth Observing System, the Tropical Rainfall Measuring Mission, and Mission to Planet Earth. A brochure describing these programs will be made available upon request for those who have not received a copy in the past years. To receive a copy, please write to the Earth Science Support Office, 300 E Street, SW, Suite 840, Washington, DC 20024.

**Terms and Conditions** — Awards are made initially for one year and may be renewed annually, usually no more than two times, based on satisfactory progress as reflected in academic performance and evaluations by the faculty advisor. The amount of award is $20,000/annum, which may be used to defray living expenses, tuition, and fees. A further amount of $2,000 is available by request for the faculty advisor's use in support of the student's research.

**Eligibility** — Students admitted to or already enrolled in a full-time Ph.D. program at accredited U.S. universities are eligible to apply. Students may enter the program at any time during their graduate work. Students may also apply in their senior year prior to receiving their baccalaureate degree, but must be admitted and enrolled in a Ph.D. program at a U.S. university at the time of the award. An individual accepting this award may not concurrently receive other Federal funds, including funds from other Federal fellowships, traineeships, or employment. United States citizens and resident aliens will be given preference, although the program is not restricted to them.

**Equal Opportunity** — No applicant shall be denied consideration or appointment as a NASA Global Change Fellow on grounds of race, creed, color, national origin, age, or sex.

**Obligation to the Government** — A student receiving support under the Global Change Fellowship Program does not thereby incur any formal obligation to the U.S. Government. However, the objectives of this program will clearly be served best if the student is encouraged to actively pursue research or teaching in global change research after completion of graduate studies.

**Disposition of Unused Funds** — In case a student or faculty advisor ceases to participate in the program for any reason, the university with prior NASA approval may appoint another student or faculty advisor to complete the remaining portion of the grant period provided the area of research remains the same. Renewal applicants who have funds remaining from their previous year's budget may carry the remaining over into the following program year.

**Selection of Proposals** — Proposals will be judged by NASA Headquarters on a competitive basis. Criteria for selection include: (a) academic excellence as based on transcripts and a letter of reference by the student's academic advisor; (b) the quality of the proposed research for students already in graduate school; and (c) the relevance of the proposed research to NASA's role in the U.S. Global Change Research Program (Mission to Planet Earth). Selection panels will

include representation from the academic community, NASA's Earth Science and Applications Division and Education Division, and professional societies in the Earth sciences.

**Application Procedures** — Applicants are required to make available: (a) a completed application form; (b) a titled five-page research proposal for those already enrolled in a program of study or a statement of research interest for those entering graduate school; (c) a short abstract (one-half page) summary describing the proposed research (if you are already enrolled in grduate school) or proposed research interests (if you are not yet enrolled); (d) copies of undergraduate and graduate transcripts; (e) a letter of reference from the academic advisor; and (f) a schedule stating your proposed start date and completion date of your plan of study and/or research program. One original and nine (9) copies of the application form, proposal, transcripts, and letter of reference should be forwarded as a package. It is the student's responsibility to ensure that these documents are received by NASA on time. The deadline for receipt of all materials at NASA Headquarters is April 1 of each year. All application packages must include debarment and suspension certifications and drug-free workplace certifications. Applications that are not complete by April 1 will not be considered in the selection process. Materials should be sent to:

NASA Global Change
Fellowship Program
Code SE-44
NASA Headquarters
Washington, DC 20546

Results of the competition will be announced June 30 of each year, with anticipated starting date of awarded fellowships to be September 1 of each year.

# PROPOSALS DUE APRIL 1

*NASA Graduate Student Fellowships in Global Change Research • Application Form*

## I. Student Information

Name: (Mr/Ms)

_____
Last First MI

Birth Date: _____

Birthplace: _____

Permanent Address*: _____

_____

Home Phone: _____

Citizenship: _____

Target Degree: __ PhD

Expected Degree Completion Date: _____

Discipline: _____

Department: _____

Campus Address*: _____

Mail Code: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____ Fax No.: _____

E-Mail: _____

Undergraduate GPA : _____ Out Of _____

Discipline: _____

Graduate GPA (If Applicable): _____ Out Of _____

## II. Faculty Advisor Information

Name: _____

Department: _____

Campus Address: _____

Mail Code: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

Fax Number: _____

E-Mail: _____

## III. Official Responsible for Committing Institution

Name: _____

Title: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

☐ Drug-Free Workplace Certification

☐ Debarment and Suspension Certification

*Signature:* _____ *Date:* _____

## IV. Proposal Information

☐ Applicable Global Change Category (check only **one** category)

__ Climate and Hydrologic Systems
__ Ecological Systems and Dynamics
__ Human Interactions
__ Solar Influences
__ Biogeochemical Dynamics
__ Solid Earth Processes
__ Data and Information Systems

Proposal Title (not to exceed 260 characters): _____

_____

_____

## V. Submission Checklist *(incomplete files will not be considered for award)*

☐ Application Form
☐ Research Proposal (5 - 6 pages)
☐ Abstract
☐ Transcripts
☐ Recommendation Letter
☐ Schedule
☐ Budget
☐ Voluntary Information Form

*I certify that I am or will be a full-time graduate student enrolled at an accredited U.S. university during the period covered in the attached proposal.*

*Signature:* _____ *Date:* _____

* Please indicate primary mailing address.

In order to determine the degree to which members of each ethnic/racial group are reached by this announcement, NASA requests that the student check the appropriate block(s). Submission of this information is voluntary.

☐ AMERICAN INDIAN ☐ ASIAN* ☐ BLACK

☐ HISPANIC ☐ PACIFIC ISLANDER** ☐ WHITE

☐ INDIVIDUAL WITH DISABILITIES ***

☐ MALE

☐ FEMALE

*This area includes, for example, China, India, Japan and Korea.

**This area includes any of the original peoples of Hawaii; the U.S. Pacific Territories of Guam, American Samoa, and the Northern Marianas, the U.S. Trust Territory of Palau; the Islands of Micronesia and Melanesia; and the Philippines.

***A disability that limits a major life activity.

# NASA Graduate Student Fellowships in Global Change Research
## Budget Information

**I. Student Stipend, Tuition, Fees, Travel** (Maximum of $20,000) $_____

**II. Faculty Advisor** (Maximum of $2,000) $_____

***Total Requested*** **$**_____
(Maximum of $22,000)

# *Section V —*

# *High Performance Computing and Communications*

# *High Performance Computing and Communications*

***In the 1993 and 1994 academic years, at least five new GSRP awards will be granted each year as part of the Federal High Performance Computing and Communications (HPCC) Program. HPCC is a multi-agency program designed to accelerate the development and application of high performance computing systems through an integrated program of hardware, software, and network development, as well as long term basic research. Within the federal program, NASA will focus on: aeronautical, Earth-science, and space-science applications; interagency software coordination; and the areas of basic research outlined below. For further information on specific research projects, please contact the individuals listed below. General information on NASA's HPCC program may be obtained by writing:***

***Directorate for High Performance Computing and Communications***
***NASA Headquarters***
***Code RC***
***Washington, DC, 20546***

***Proposals for HPCC/GSRP fellowships must be sent to the centers listed and must be coordinated with the designated points of contact.***

***For detailed instructions on administrative procedures and proposal format for the High Performance Computing and Communications program see pages 14-19.***

## Ames Research Center

Contact: Kenneth G. Stevens, Jr.
(415) 604-5949
stevens@nas.nasa.gov

**HPCC/Computational Aerosciences Project —** A new generation of massively parallel systems is being developed which can be used to solve computational aeroscience problems. Research of interest includes: systems software which facilitates the efficient use of parallel systems; multidiscipline computational applications for parallel systems; and computer architectural analysis of the Intel Paragon, Thinking Machines CM5, and other emerging parallel processors. To support HPCC research, Ames has available conventional supercomputers, advanced parallel processors, state of the art workstations and high speed networks.

## Goddard Space Flight Center

Contact: Jim Fischer
(301) 286-3465
fischer@nibbles.gsfc.nasa.gov

**HPCC/Earth and Space Sciences (ESS) Project —** This project focuses on development of scalable algorithms and applications on massively parallel computing systems to make progress toward the solution of Grand Challenge investigations in a broad range of Earth and space science disciplines. In support of the Grand Challenge investigations, ESS is interested in developing advanced software technology including parallel computational techniques, approaches for architecture independent parallel programming, and software tools for accessing and managing massive science data sets.

## Jet Propulsion Laboratory

Contact: Robert D. Ferraro
(818) 354-1340
ferraro@zion.jpl.nasa.gov

**HPCC/Earth and Space Sciences (ESS) Project —** JPL is conducting research in system software, user tools, and parallel computational methods for MIMD (Multiple-Instruction Multiple-Data) architectures. These software tools include parallel programming paradigms, decomposition and load balancing methods, and support for solving partial differential equations, such as unstructured mesh generation and linear equations solvers. The tools are in support of the HPCC ESS applications, which include multi-disciplinary modeling of Earth and space phenomena, and analysis of data from remote sensing instruments.

## Langley Research Center

Contact: Manuel D. Salas
(804) 864-2254
mdsalas@nasamail.nasa.gov

**HPCC/Computational Aerosciences Project** — Research interests include, but are not limited to, the following areas: research on numerical methods for the solution of tightly coupled multidisciplinary problems that can be efficiently implemented on massively parallel computers; research on novel optimization methods that are robust and can efficiently solve problems with a large number of design variables and constraints as they occur in the design of aircraft shapes; and research on data management, domain decomposition methods, and/or data visualization for multi-disciplinary problems using massively parallel computers.

## Lewis Research Center

Contact: Russell Claus
(216) 433-5869
claus@lercuts.lerc.nasa.gov

**HPCC/Computational Aerosciences Project (Numerical Propulsion Simulation)** — The development of a propulsion system simulation requires the integration of disciplines, components and high-performance computers into a high-level software environment. Of particular interest is the structuring of object-oriented component models within a dataflow control network. The numerically intensive component models will employ various parallel processing strategies to speed the overall system processing times. Various algorithms will be explored to solve complex-geometry, time-varying, engine system problems on a heterogeneous network of computers.

# PROPOSALS DUE FEBRUARY 1

*NASA Graduate Student Researchers Program in High Performance Computing and Communication (HPCC)*
*Proposal Cover Sheet*

## I. Student Information

Name: (Mr/Ms)

Last First MI

Birth Date: _____

Birthplace: _____

Home Address: _____

_____

Home Phone: _____

Target Degree: __ MS __ MS/PhD (Joint) __ PhD

Discipline: _____

Department: _____

Campus Address: _____

Mail Code: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____ Fax No.: _____

E-Mail: _____

Undergraduate GPA : _____ Out Of _____

Discipline: _____

Graduate GPA (If Applicable): _____ Out Of _____

Discipline: _____

*I certify that I am a citizen of the United States and that I am or will be a full-time graduate student at the university during the period covered in this proposal.*

*Signature:* _____ *Date:* _____

## II. Faculty Advisor Information

Name: _____

Department: _____

Campus Address: _____

Mail Code: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

Fax Number: _____

E-Mail: _____

*Signature:* _____ *Date:* _____

## III. Official Responsible for Committing Institution

Name: _____

Title: _____

University: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

*Signature:* _____ *Date:* _____

## IV. Proposal Information

Type of Proposal:

☐ (1) New ☐ (2) Second Year ☐ (3) Third Year *If Renewal, Designate Grant No.:* **NGT-** _____

Proposed Start or Renewal Date: _____ Expected Completion Date: _____

Proposal Title: _____

_____

## V. Submission Information

☐ NASA Centers

__ Ames/Dryden (ARC/DFRF)

__ Goddard (GSFC)

__ Jet Propulsion Lab (JPL)

__ Langley (LaRC)

__ Lewis (LeRC)

Center Technical Advisor:

_____

Other Facilities to which this proposal is being submitted:

_____

## VI. Proposal Checklist

☐ Original and 9 Copies

☐ Original Transcripts

☐ Signed Advisor Evaluation

☐ Budget Form

☐ University Certifications
- Suspension and Debarment
- Drug Free Workplace

## *VII. NASA Use Only*

☐ Org/Cpys

☐ OT

☐ SAE

☐ BdgtFrm

☐ UCert

☐ Returned Proposal

In order to determine the degree to which members of each ethnic/racial group are reached by this announcement, NASA requests that the student check the appropriate block(s). Submission of this information is voluntary.

☐ AMERICAN INDIAN ☐ ASIAN* ☐ BLACK

☐ HISPANIC ☐ PACIFIC ISLANDER** ☐ WHITE

☐ INDIVIDUAL WITH DISABILITIES ***

☐ MALE

☐ FEMALE

*This area includes, for example, China, India, Japan and Korea.

**This area includes any of the original peoples of Hawaii; the U.S. Pacific Territories of Guam, American Samoa, and the Northern Marianas, the U.S. Trust Territory of Palau; the Islands of Micronesia and Melanesia; and the Philippines.

***A disability that limits a major life activity.

# NASA Graduate Student Researchers Program in High Performance Computing and Communication

## Budget Information

**I. Student Stipend** (Maximum of $16,000) $_____

**II. Student Allowance** (Itemize if necessary)

Student Allowance Total $_____
(Maximum of $3,000)

**III. University Allowance** (Itemize if necessary)

University Allowance Total $_____
(Maximum of $3,000)

***Total Requested*** **$**_____
(Maximum of $22,000)